FLOOD INSURANCE STUDY

SHASTA COUNTY, CALIFORNIA
UNINCORPORATED AREAS

SEPTEMBER 27, 1985

Federal Emergency Management Agency

COMMUNITY NUMBER - 060358

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1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the unincorporated areas of Shasta County, California, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert Shasta County to the regular program of flood insurance by the Federal Emergency Management Agency. Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these federally supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3. In such cases, however, it shall be understood that the State (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgments

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for Tormey Drain were performed for the Federal Emergency Management Agency by the U.S. Army Corps of Engineers, under Inter-Agency Agreement Nos. IAA-H-16-75 and IAA-H-7-76, Project Order Nos. 17 and 1, respectively, and were completed in June 1976.

The hydrologic analyses for the Sacramento River were performed by the U.S. Army Corps of Engineers in 1977.

The hydrologic and hydraulic analyses for Burney Creek, Burney Creek West Branch, Churn Creek, Clover Creek, Cow Creek (Near Millville), Cow Creek (Near Palo Cedro), Dry Creek, and Little Cow Creek, and hydraulic analyses for the Sacramento River were performed for the Federal Emergency Management Agency by the California Department of Water Resources, under Contract No. H-4571. This work, which was completed in 1981, and that work completed in 1976 and 1977 and mentioned above, covered all significant flooding sources affecting the unincorporated areas of Shasta County.

Hydraulic analyses for portions of Churn Creek were performed for the Federal Emergency Management Agency by Dames & Moore, under Contract No. C-0542 and completed in November 1983.

1.3 Coordination

The stream reaches to be studied by detailed methods and approximate methods were determined at a meeting attended by representatives of the California Department of Water Resources, the Federal Emergency Management Agency, and Shasta County in June 1977.

The study contractor contacted the U.S. Army Corps of Engineers, the U.S. Geological Survey, and the U.S. Soil Conservation Service for information pertinent to this study. This information was combined with that hydrologic and hydraulic work performed by the study contractor to prepare this Flood Insurance Study.

On January 30, 1981, the results of the study were reviewed at the intermediate meeting attended by representatives of the study contractor, the Federal Emergency Management Agency, and the county.

On March 6, 1984, a final meeting was held to review the results of the study. The county supported an appeal to 100-year elevations on the Sacramento River made by the City of Redding. As a result, revisions were made to the 100-year flood boundaries and water-surface elevations on the Sacramento River in the vicinity of Redding; revisions were also made to Redding's corporate limits to reflect annexations.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the unincorporated areas of Shasta County. The area of study is shown on the Vicinity Map (Figure 1).

Areas not included in this study are the incorporated areas of the City of Anderson and the City of Redding.

Areas studied by detailed methods are listed in Table 1.

Those areas studied by detailed methods were chosen with consideration given to all proposed construction and forecasted development through 1986.

Areas studied by approximate methods are listed in Table 2.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by the Federal Emergency Management Agency and Shasta County.

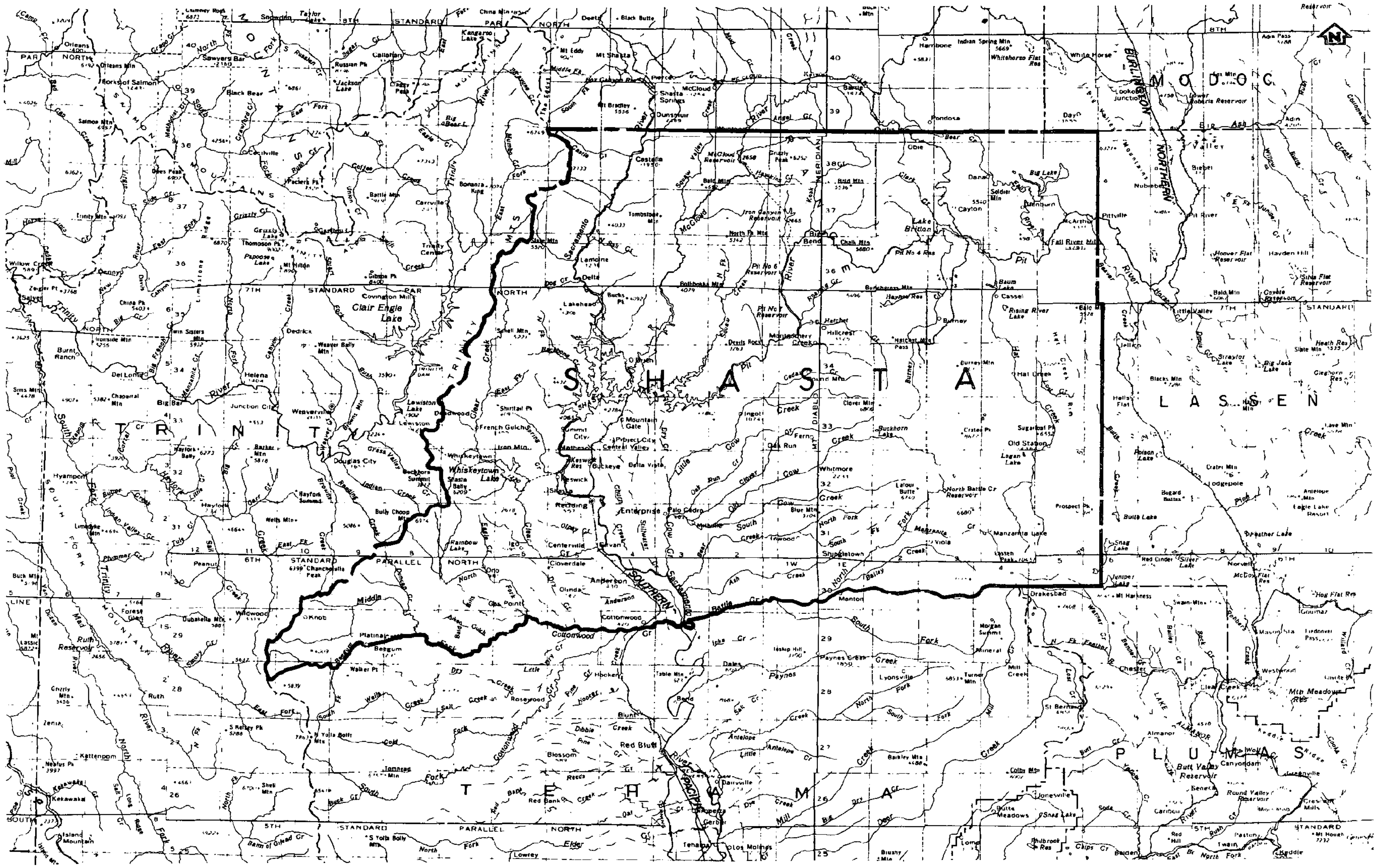

FIGURE 1	FEDERAL EMERGENCY MANAGEMENT AGENCY SHASTA COUNTY, CA (UNINCORPORATED AREAS)	APPROXIMATE SCALE 16 0 16 32 48 MILES VICINITY MAP

Table 1. Areas of Detailed Study

Stream	Miles Studied	Description
Burney Creek	1.8	Northeast corner of Shasta County at Burney (Sec. 19 to Sec. 17, T35N, R3E).
Burney Creek West Branch	1.7	Northeast corner of Shasta County at Burney (Sec. 19 to Sec. 17, T35N, R3E).
Churn Creek	5.8	East of Sacramento River near Redding for all of Churn Creek in the county between Rancho Road and Interstate Highway 5 crossings (Sec. 17, T31N, R4W to Sec. 7, T32N, R4W).
Clover Creek	1.3	5 miles east of Redding from mouth to 1.3 miles upstream (Sec. 10 to Sec. 11 of T31N, R3W).
Cow Creek	4.3	East of Redding in southern Shasta County: 1.2 miles near mouth of Little Cow Creek (Sec. 8, T31N, R3W); and 3.0 miles near Millville (Sec. 10, T31N, R3W to Sec. 13, T31N, R3W).
Dry Creek	2.2	East of Redding in southern Shasta County near Bella Vista (Sec. 17 to Sec. 6 of T32N, R3W).
Little Cow Creek	1.1	East of Redding in southern Shasta County from mouth of Little Cow Creek to 1.1 miles upstream (middle of Sec. 8 to middle of Sec. 5 of T31N, R3W).
Sacramento River	8.5	Near mouth of Churn Creek to Redding corporate limits (Sec. 10, T30N, R4W to Sec. 32, T31N, R4W).
Tormey Drain	0.3	Approximately 300 feet northeast of the intersection of Balls Ferry Road and Stingy Lane in Anderson to Dodson Lane.

Table 2. Areas of Approximate Study

Stream	Miles Studied	Description
Castle Creek	0.3	3 miles south of north Shasta County limits on west side of Sacramento River from mouth to 0.3 mile upstream (on line between Sec. 15 and 22, T38N, R4W).
Churn Creek	6.9	East of Sacramento River near Redding.
Clough Creek	1.5	East of Sacramento River and Redding.
Cottonwood Creek	9.0	Along south Shasta County limits on west side of Sacramento River near community of Cottonwood from mouth to confluence with South Fork Cottonwood Creek (Sec. 9, T29N, R3W to Sec. 16, T29N, R4W).
Cow Creek	7.8	In southern Shasta County east of Redding and the Sacramento River. 6.1 miles from Dersch Road crossing to 0.5 mile below mouth of Little Cow Creek (Sec. 5, T30N, R3W to Sec. 8, T31N, R3W). 1.7 miles from mouth of Oak Run Creek to 0.5 mile below mouth of Clover Creek near Millville (Sec. 8, T31N, R3W to Sec. 10, T31N, R3W).
Dry Creek	0.9	7 miles east of Redding from mouth to Meyer Road (Sec. 20 to 17 of T32N, R3W).
Fall River	0.6	At Fall River Mills near mouth to dam (Sec. 25, T37N, R4E to Sec. 31, T37N, R5E).

Table 2. Areas of Approximate Study (Cont'd)

Stream	Miles Studied	Description
Hat Creek	10.1	5.3 miles: 8 miles southeast of Burney from State Highway 89 near Brown Butte to Hat Creek Post Office (Sec. 33, T35N, R4E to Sec. 22, T34N, R4E). 1.5 miles: 12 miles southeast of Burney near Wilcox School (Sec. 35, T34N, R4E to Sec. 1, T33N, R4E). 0.8 mile: 9 miles southeast of Burney near Old Station (Sec. 33 to 32 at T33N, R5E). 2.5 miles: 19 miles southeast of Burney near Old Station Post Office and Big Springs Campground (Sec. 6, T32N, R4E).
Little Cow Creek	3.2	5 miles east of Redding from 1.1 miles above mouth to mouth of Dry Creek (Middle of Sec. 5, T31N, R3W to Sec. 17, T32N, R3W).
Pit River	1.5	At Fall River Mills (Sec. 29 to 31 of T37N, R5E).
Sacramento River	16.4	10.1 miles in southern Shasta County from 0.9 mile upstream of Cottonwood Creek mouth to mouth of Churn Creek. 6.3 miles in northern Shasta County from Sweetbriar to county limits (Sec. 27 to Sec. 1 of T38N, R4W).
Salmon Creek	5.1	East of Sacramento River and Redding. From mouth near State Highway 44 to State Highway 299 crossing (Sec. Line between Sec. 2 and 11 of T31N, R4W to Sec. 13, T32N, R4W).

Table 2. Areas of Approximate Study (Cont'd)

Stream	Miles Studied	Description
Salt Creek	3.3	1 mile north of Redding from Interstate Highway 5 through Project City (Sec. 7, T32N, R4W to Sec. 30, T33N, R4W).
Stillwater Creek	9.0	East of Sacramento River and Redding.
		6.0 miles from north end of Redding Municipal Airport to 1.0 mile above Loomis Corners (Sec. Line between Sec. 23 and 26, T31N, R4W, to middle of Sec. 27, T32N, R4W).
		0.6 mile from below West and East Forks of Stillwater Creek to their confluence.
		1.1 miles from mouth of forks up East Fork Stillwater Creek (Sec. 15 to 9 of T32N, R4W).
		1.3 miles from mouth of forks up West Fork Stillwater Creek (Sec. 15 to 10 of T32N, R4W).
Unnamed Tributary to Tormey Drain	0.2	West of Anderson northeast of the intersection of State Highway 273 and Third Street.

2.2 Community Description

Shasta County is located at the north end of the Sacramento Valley in north-central California. It is bordered by Trinity County on the west, Siskiyou County on the north, Modoc County on the northeast, Lassen County on the east, Tehama County on the south, and Plumas County on the southeast. The total land area within the county is 3,850 square miles.

The 1980 population was 115,715, up from 77,640 in 1970 (Reference 1).

Over 80 percent of the county's total population is concentrated in the Sacramento Valley area within an area of approximately 450 square miles. The balance of the population is located in the mountainous regions in the western, northern, and eastern parts of the county.

The county has two incorporated cities, Redding and Anderson. The 1980 census figures for Redding and Anderson were 41,995 and 7,381, respectively (Reference 1).

Burney Creek flows northeast, turning north as it passes through the unincorporated area of Burney. The drainage area near Burney is approximately 89 square miles. The confluence of Burney Creek with Pit River is approximately 4 miles north of Burney. The flood plain in the Burney area is wide and flat.

Churn Creek, an intermittent stream, has a long narrow basin that lies entirely in the southwest portion of Shasta County and is tributary to the Sacramento River. Elevations in the basin range from approximately 400 feet at the confluence of Sacramento River near the City of Anderson to approximately 2,000 feet near its headwaters. The total drainage area is 42 square miles.

The confluence of Clover Creek with Cow Creek is near the unincorporated area of Millville, and has a drainage area of approximately 53 square miles. Elevations in the drainage basin range from approximately 490 feet near Millville to approximately 5,400 feet at the headwaters near Stacher Butte and Dan Hunt Mountain.

The Cow Creek drainage basin lies in the northern end of the Sacramento Valley. The basin is bordered by the drainage basins of Pit River on the north and east, Churn Creek on the west, and Bear Creek on the south. Elevations range from approximately 380 feet at the confluence with Sacramento River to approximately 6,700 feet near the headwaters. Cow Creek has a drainage area of approximately 427 square miles near the unincorporated area of Millville.

Dry Creek flows south to its confluence with Little Cow Creek near the unincorporated area of Palo Cedro. The drainage basin lies in the northern portion of the Sacramento Valley. Dry Creek drains an area of approximately 12 square miles at U.S. Highway 299.

Little Cow Creek has a drainage area of 145 square miles at Palo Cedro. The creek flows southwest before turning south to its confluence with Cow Creek.

The Sacramento River basin above Shasta Dam is drained by Pit and McCloud Rivers and the upper reaches of Sacramento River. The basin covers an area of approximately 6,421 square miles at Shasta Dam excluding Goose Lake drainage of Pit River, which, although within the Pit River Basin, rarely contributes to flow. The headwaters of the Sacramento River originate in the Cascade Range. Elevations in the drainage basin range from approximately 350 feet to approximately 10,000 feet.

Tormey Drain originates in the west-central part of Anderson as a local street drainage system; hence, it can only carry small flows. A portion of Tormey Drain flows through the county before re-entering Anderson near Dodson Lane.

The economy of Shasta County revolves around three primary activities: the recreation industry, the timber industry, and the agricultural industry.

The climate in Shasta County varies due to the considerable elevation differences in the county. For the most part, the summers are hot and dry and winters mild, although in the mountainous regions snowfall is common. Average precipitation varies from 41 inches at Redding to over 70 inches in the mountains. Over 90 percent of the precipitation occurs from October through April.

All areas of the county drain to the Sacramento River, then south through the Sacramento Valley. Elevations in the county vary from approximately 350 feet along the Sacramento River near Cottonwood to a maximum of 10,457 feet on Lassen Peak near the southeastern corner of the county. The soils of the county were derived from a variety of sources and are difficult to generalize. The agriculturally important soils are the alluvial soils deposited along streams. Natural vegetation varies from grassland-oak at the lowest elevations to extensive mixed conifer forests above approximately 2,000 feet.

Considerable residential development has occurred in the flood plains of Churn and Burney Creeks. A smaller degree of residential and commercial development has occurred along the Sacramento River at Redding. Additional areas where residential development has occurred in the flood plain include Hat Creek and the upper Sacramento River at Castella.

2.3 Principal Flood Problems

The operation of Shasta Dam, constructed in the early 1940s, resulted in regulating the 10-, 50-, and 100-year floods to 79,000 cubic feet per second (cfs) in the Redding area, from Keswick to Clear Creek. This gave Redding and Anderson a high degree of flood protection.

The two largest floods since the construction of the dam occurred in 1970 and 1974. Peak discharges for the Sacramento River at Keswick for these years were estimated to have been 78,900 cfs and 81,400 cfs, respectively. Both floods were approximately 100-year events at Redding. Reported economic losses in Shasta County amounted to $3,790,000 in 1970 and $10,650,000 in 1974. It is believed that the actual losses were considerably greater.

The pre-Shasta Dam flood of 1940 on the Sacramento River was estimated to have had a peak flow of 186,000 cfs, which is equal to a 180-year flood under present conditions. The estimated total flood damages for the 1940 flood in Shasta County were $278,000.

The peak flows of historical floods on the Sacramento River are shown below.

Date	Peak Flow (cfs)
December 1937	132,000[1]
February 1940	186,000[1]
March 1941	98,200[1]
February 1942	85,200[2]
December 1951	42,100[2]
February 1955	51,100[2]
February 1958	78,800[2]
December 1964	54,000[2]
January 1969	56,000[2]
January 1970	78,900[2]
April 1974	81,400[2]

[1] At the Sacramento River Bridge at Kennett before the construction of Shasta Dam

[2] At the Sacramento River at Kewsick above Redding, California

Another area of frequent flooding is Cottonwood Creek which lies on the southern Shasta-Tehama County limits. The drainage area of Cottonwood Creek is approximately 1,000 square miles. Most of the development, residential and agricultural, extends from the mouth to 7 miles upstream. In 1970, a flood of 58,500 cfs caused damage estimated at $700,000, and in 1974, a flow of 70,000 cfs caused

damage estimated at $1 million. Almost all of the damage was incurred within this 7-mile reach of the stream. Listed below are peak flows of historical floods on Cottonwood Creek near Cottonwood.

Date	Cottonwood Creek [1]
March 1941	52,300
February 1942	42,600
December 1951	32,600
December 1955	49,000
February 1958	48,600
December 1964	60,000
January 1969	23,500
January 1970	58,500
January 1974	70,000

[1] At the Cottonwood Creek near Cottonwood gage

Burney Creek at Burney, which is in northeastern Shasta County, is subject to flooding due to high flows. In 1970, a flood of 4,910 cfs caused an estimated $535,000 in flood damage, and in 1974, a flood of 2,890 cfs caused an estimated $160,000 in flood damage (Figure 2).

Among the reasons for the flooding at Burney are the narrowing of the channel just above Burney and several sharp bends in the stream as it passes through Burney.

Natural obstructions to floodflows on Churn, Clover, Cow, Dry, and Little Cow Creeks include trees, brush, and other vegetation growing in and along the flood plains. Debris contributed to increased flood damage on Churn Creek during the December 1964 flood (Reference 2). General rainfloods in these drainage basins as well as along Tormey Drain can occur at any time between November and March. This type of flood results from prolonged heavy rainfall and is characterized by high peak flows of moderate duration. Flooding is more severe when antecedent rainfall has resulted in saturated ground conditions. Snowfall rarely occurs along the tributary streams joining the Sacramento River between Shasta Dam and Anderson. Consequently, snowmelt flooding originating downstream from Shasta Dam is not a hazard.

2.4 Flood Protection Measures

The significant structures providing flood protection are Shasta Dam on the Sacramento River and Whiskeytown Dam on Clear Creek. The effect of Shasta Dam was discussed in the previous section.

Although Whiskeytown Dam did not include flood control as a project purpose, the Water and Power Resources Service operates the top 10

Figure 2. Downtown Burney in 1974 flood. (Photo courtesy of Shasta County Department of Water Resources.)

feet of the reservoir for flood control. This provides significant flood reduction on Clear Creek.

The U.S. Army Corps of Engineers is designing authorized flood control dams on Cottonwood Creek, which joins the Sacramento River at the southern edge of Shasta County. Construction of these dams would reduce the 100-year flood peak along Cottonwood Creek, near Cottonwood, from 108,000 cfs to 15,000 cfs.

A project to provide flood protection along lower Churn Creek was authorized by the U.S. Army Corps of Engineers in 1971 under its small flood control projects authority. However, the project did not proceed because local interests did not provide assurances on the cost-sharing requirements.

The county currently has a flood plain zoning ordinance in effect that applies to all areas shown as Zone A on the Flood Hazard Boundary Map (Reference 3). The ordinance identifies two flood zones. The F-1 zone is the floodway area as determined by the State Reclamation Board in its designated floodway program. The F-2 zone is the flood fringe area which covers all Zone A areas shown on the Flood Hazard Boundary Map.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual occurrence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported here reflect flooding potentials based on conditions existing in the county at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence

intervals for each flooding source studied in detail affecting the county.

The hydrologic analyses for the Sacramento River used in this study were developed by the U.S. Army Corps of Engineers, Sacramento District, for the Cottonwood Creek Project. These analyses were published in Design Memorandum No. 1, Cottonwood Creek, California, Hydrology, in July 1977 (Reference 4). This report discusses methods used to establish peak flows on the Sacramento River between Keswick and Ord Ferry, including the sections in Shasta County.

The regulated frequency-discharge curves developed by the U.S. Army Corps of Engineers consider the operating criteria for Shasta and Whiskeytown Reservoirs. The operation of Shasta Reservoir (capacity 4,552,000 acre-feet at normal full pool) has a major effect on the flow regimen of the Sacramento River below the dam. Shasta Reservoir can control inflow of its 6,420-square-mile drainage area up to approximately the 100-year flood level and limit flows to 79,000 cfs. Therefore, existing-condition flow-frequency curves were computed for locations below the dam using the period of record since Shasta Dam was constructed (1945-1976), which includes the regulatory effects of the dam. Simulated operation for the years prior to 1945 is valuable for providing water-supply data, but was not used to determine regulated flood peaks because of the inaccuracies of such a method. The 1945 through 1976 period includes both dry and wet periods and is representative of a long period of record. The recorded flows for the period from 1945 to 1964 were adjusted to account for the operation of Whiskeytown Reservoir.

To extend the flow frequency curves to include very rare events, such as the 1 percent and rarer floods, hypothetical floods were routed through the existing reservoir system. To account for variability of reservoir effectiveness because of storm centerings, three different centerings were used. The storms were centered over the Sacramento River above Shasta Dam, over the Cottonwood Creek basin, and over the Cow Creek Basin. Historically, approximately 50 percent of the flood-producing storms have occurred above Shasta Dam and approximately 50 percent below the dam. Also, the storms below the dam have occurred almost equally between the east side of the valley and the west side of the valley. Therefore, the storm centerings were given the following weight:

Above Shasta Dam	50 percent
Cottonwood Creek	25 percent
Cow Creek	25 percent

For convenience, the standard project storm centerings developed for the Sacramento River basin were used as the basis for the hypothetical floods. The floods were increased or decreased by fixed percentages to obtain 100-, 200-, and 500-year floods.

Because there are no streamflow records for Tormey Drain, peak flows of the standard project floods were synthesized from records of stream basins nearby having similar hydrologic, meteorologic, and physiographic characteristics. The peak flows thus developed take into account basin runoff characteristics, reduction of runoff through infiltration, surface pondage, and other factors. Ratios of the computed standard project flood were used to determine the 10-, 50-, 100-, and 500-year flood events in areas where stream gage data were not available.

Discharges for Burney Creek, Burney Creek West Branch, Churn Creek, Clover Creek, Cow Creek, Dry Creek, and Little Cow Creek were developed primarily by the U.S. Army Corps of Engineers based on statistical analysis of available streamflow records for Churn Creek, supplemented by records from adjacent streams having similar characteristics (Reference 2). Adjustments were made to streams other than Churn Creek depending on drainage areas above the reaches being considered.

Peak discharge-drainage area relationships for streams studied by detailed methods are shown in Table 3.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in the county were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flooding sources.

Water-surface elevations of floods of the selected recurrence intervals were computed through use of the U.S. Army Corps of Engineers HEC-2 step-backwater computer program (Reference 5).

HEC-2 water-surface elevations were adjusted for the Sacramento River in the vicinity of the City of Redding, based on historic high-water marks established by four different agencies: City of Redding, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and CH2M Hill (Reference 6). All high-water marks were set in 1970 and 1974 corresponding to 79,000 cfs releases from Keswick Dam. This discharge is equal to the 100-year flood flow for the Sacramento River at Redding. High-water marks were plotted on profiles, and from these points a historic 100-year flood profile was developed by interpolation.

Cross sections for the backwater analyses of the Sacramento River and its tributaries were digitized using aerial photographs at a scale of 1:12,000 (Reference 7). The below-water sections were obtained by field measurement. Cross sections for Burney Creek and Burney Creek West Branch were field surveyed. All bridges, dams, and culverts were field checked to obtain elevation data and structural geometry.

Table 3. Summary of Peak Discharges

Stream and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Burney Creek Near Burney	88.8	2,200	5,300	7,300	15,200
Burney Creek West Branch At U.S. Highway 299	--[1]	200	1,300	3,200	10,500
Churn Creek At Rancho Road	33.9	6,900	10,400	11,900	16,000
Clover Creek At Millville	52.5	3,530	5,650	6,700	9,790
Cow Creek Near Millville	427.0	32,600	47,200	54,100	79,900
Dry Creek At U.S. Highway 299	12.3	1,080	1,730	2,060	3,010
Little Cow Creek At Palo Cedro	145.0	11,300	18,100	21,500	30,900
Sacramento River Above Clear Creek	6,500	79,000	79,000	79,000	319,000
Sacramento River Above Churn Creek	6,800	88,000	102,000	112,000	351,000
Sacramento River Below Battle Creek	8,800	131,000	219,000	281,000	525,000
Tormey Drain At Dodson Lane	1.8	410	580	670	800

[1]Drainage Area Not Applicable Due to Divergence of Flows From Burney Creek

Cross sections for Churn Creek were taken from orthophoto maps at a scale of 1:2,400 (Reference 8) supplied by the City of Redding and from the maps referenced above (Reference 7).

Cross sections for the backwater analyses of Tormey Drain were furnished by the City of Anderson, or developed in whole or in part from topographic maps at scales of 1:1,200 (Reference 9), and 1:24,000, enlarged to 1:12,000 (Reference 10).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment based on field observations of the streams and flood plain areas. Roughness values used for the main channel of the Sacramento River and its tributaries and Burney Creek generally ranged from 0.023 to 0.080, while flood plain roughness values generally ranged from 0.030 to 0.080 for all floods. The acceptability of all assumed hydraulic factors, cross sections, and hydraulic structure data was checked by computations that duplicated historic floodwater profiles.

Starting water-surface elevations for all detailed studied flooding sources were calculated using the slope-area method. Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

Elevations for the unnamed tributary to Tormey Drain, which was studied by approximate methods, were determined from field surveys.

For the upper portion of Sacramento River studied by approximate methods, elevations were determined using the Dunsmuir, California, Flood Insurance Study (Reference 11) and topographic maps (Reference 12).

Elevations for the approximate flooding on Anderson Creek were taken from the Flood Plain Information report for Anderson, California (Reference 13).

Elevations for all other streams studied by approximate methods were determined from Manning's equation based on surveyed cross sections, topographic maps (References 14 and 15), computed discharges for each stream using the Churn Creek Flood Plain Information report (Reference 2), and supplemented by the U.S. Department of Agriculture report Estimating Runoff in California (Reference 16).

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Emergency Management Agency as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the county. For Clover Creek, Cow Creek (Near Millville), Cow Creek (Near Palo Cedro), Dry Creek, Little Cow Creek, and portions of the Sacramento River the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were developed photogrammetrically, using aerial photographs at a scale of 1:12,000 (Reference 7). Boundaries for Burney Creek and Burney Creek West Branch were developed using orthophoto topographic maps at a scale of 1:2,400 (Reference 17). The boundaries for the Sacramento River were developed using orthophoto maps which incorporated aerial photos of the 1974 flood at a scale of 1:2,400 and a contour interval of 1-4 feet (Reference 8). The boundaries for Tributary to Churn Creek and Churn Creek were developed using orthophoto maps at a scale of 1:2,400 and a contour interval of 1-4 feet (References 8 and 18).

Flood boundaries for Tormey Drain have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000, enlarged to a scale of 1:12,000, with a contour interval of 10 feet (Reference 10). Adjustments were made by field observation and engineering judgment.

Approximate flood boundaries for Anderson Creek were taken from the Flood Plain Information report for Anderson, California (Reference 13).

Approximate flood boundaries for Tormey Drain were delineated based on personal observations by Shasta County Water Agency personnel and residents of the area.

Approximate flood boundaries in some portions of the study area were taken from the Flood Hazard Boundary Map (Reference 3).

The study contractor has determined that some areas shown on the Flood Hazard Boundary Map (Reference 3) are areas of minimal flooding; therefore, they were not delineated on the maps.

For the unnamed tributary to Tormey Drain studied by approximate methods, the boundaries of the 100-year flood were delineated using topographic maps and the elevations determined by field survey at a scale of 1:24,000, enlarged to 1:12,000, with a contour interval of 10 feet (Reference 10).

Flood boundaries for the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood boundaries are close together, only the 100-year flood boundary has been shown. Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to limitations of the map scale, such areas are not shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of the Federal Emergency Management Agency limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this report are presented to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

The floodways presented in this study were computed on the basis of equal-conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 4).

The floodway for the Sacramento River was developed using the U.S. Army Corps of Engineers HEC-2 step-backwater computer program (Reference 5) and based on equal-conveyance reduction. However,

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Burney Creek								
A	0	1,295	2,018	2.0	3,101.0	3,101.0	3,102.0	1.0
B	600	925	2,054	2.0	3,102.2	3,102.2	3,103.0	0.8
C	1,630	835	1,915	2.1	3,104.5	3,104.5	3,104.9	0.4
D	2,780	732	1,696	2.4	3,107.0	3,107.0	3,107.5	0.5
E	3,880	562	1,183	3.5	3,109.4	3,109.4	3,109.9	0.5
F	5,080	493	1,445	2.8	3,113.4	3,113.4	3,113.9	0.5
G	6,080	506	1,275	3.2	3,116.8	3,116.8	3,117.3	0.5
H	7,080	462	977	4.2	3,121.1	3,121.1	3,121.6	0.5
I	7,962	122	673	6.1	3,125.7	3,125.7	3,125.7	0.0
J	8,789	80	633	6.5	3,130.9	3,130.9	3,131.0	0.1
K	9,694	150	1,070	6.8	3,137.4	3,137.4	3,137.6	0.2
L	10,424	128	873	8.4	3,145.9	3,145.9	3,145.9	0.0
M	10,859	187	1,760	4.1	3,152.9	3,152.9	3,153.0	0.1
N	11,529	940	3,754	1.9	3,153.6	3,153.6	3,154.2	0.6
O	12,069	650	1,698	4.3	3,155.8	3,155.8	3,156.7	0.9

[1] Feet Above Downstream Limit of Detailed Study

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOODWAY DATA

BURNEY CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Burney Creek West Branch								
A	0	544	1,437	2.2	3,100.7	3,100.7	3,101.7	1.0
B	600	570	1,178	2.7	3,102.5	3,102.5	3,103.4	0.9
C	1,410	763	1,429	2.2	3,104.9	3,104.9	3,105.9	1.0
D	2,110	700	1,271	2.5	3,107.1	3,107.1	3,107.9	0.8
E	2,765	715	1,190	2.7	3,109.8	3,109.8	3,110.7	0.9
F	3,865	703	1,438	2.2	3,113.6	3,113.6	3,114.6	1.0
G	5,075	492	1,236	2.6	3,116.8	3,116.8	3,117.7	0.9
H	6,165	776	1,454	2.2	3,121.1	3,121.1	3,121.9	0.8
I	6,970	763[2]	1,228	2.6	3,126.4	3,126.4	3,127.3	0.9
J	8,040	329	663	4.8	3,131.3	3,131.3	3,132.1	0.8
K	8,770	299	673	4.8	3,135.0	3,135.0	3,135.6	0.6

[1]Feet Above Downstream Limit of Detailed Study [2]Width Includes Island

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOODWAY DATA

BURNEY CREEK WEST BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Churn Creek								
A	32,033	145	1,661	7.2	464.2	464.2	464.9	0.7
B	33,803	153/113[2]	1,024	11.6	466.1	466.1	466.1	0.0
C	35,033	493/353[2]	2,813	4.2	470.9	470.9	471.8	0.9
D	36,333	536/476[2]	1,891	6.3	473.2	473.2	474.2	1.0
E	49,733	205/150[2]	1,758	5.7	517.4	517.4	518.4	1.0
F	51,033	270/250[2]	1,680	6.0	520.4	520.4	520.6	0.2
G	52,233	124/64[2]	976	10.2	523.9	523.9	523.9	0.0
H	69,933	372	3,733	2.2	597.3	597.3	597.8	0.5
I	70,623	391	3,792	2.2	598.3	598.3	598.9	0.6
J	72,073	203	1,458	5.7	598.6	598.6	599.1	0.5
K	73,573	499/450[2]	1,950	3.8	602.0	602.0	602.1	0.1
L	74,573	162	759	9.8	604.4	604.4	604.4	0.0
M	75,573	211	1,139	6.5	609.6	609.6	610.5	0.9
N	76,573	264	1,180	6.3	614.4	614.4	614.4	0.0
O	77,573	281	1,253	4.3	617.2	617.2	617.3	0.1
P	78,873	186	627	8.4	622.2	622.2	622.2	0.0
Q	80,213	207	766	6.9	632.3	632.3	632.9	0.6

[1]Feet Above Confluence With Sacramento River [2]Width/Width Within County Limits

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOODWAY DATA

CHURN CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Clover Creek								
A	940	220	2,077	3.2	482.5	482.5	483.0	0.5
B	1,140	206	1,696	3.9	482.6	482.6	483.1	0.5
C	1,800	151	1,112	6.0	484.8	484.8	485.2	0.4
D	3,090	147	1,133	5.9	488.9	488.9	488.9	0.0
E	4,070	75	695	9.6	494.0	494.0	494.0	0.0
F	5,320	120	1,030	6.5	499.7	499.7	500.1	0.4
G	6,450	85	813	8.2	503.3	503.3	503.8	0.5

[1]Feet Above Confluence With Cow Creek (Near Millville)

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOODWAY DATA

CLOVER CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Cow Creek (Near Millville)								
A	0	340	4,047	7.2	474.3	474.3	475.3	1.0
B	1,850	554	3,010	9.6	479.4	479.4	480.1	0.7
C	4,850	382	3,545	6.3	488.6	488.6	489.6	1.0
D	6,400	202	2,289	9.7	493.3	493.3	493.6	0.3
E	7,800	193	2,570	8.7	499.9	499.9	500.7	0.8
F	8,340	330	3,445	6.5	501.5	501.5	502.5	1.0
G	8,740	198	2,399	9.3	502.7	502.7	503.4	0.7
H	9,740	419	3,216	6.9	505.4	505.4	506.3	0.9
I	11,740	473	3,278	6.8	510.3	510.3	511.3	1.0
J	12,740	377	3,331	6.7	512.9	512.9	513.8	0.9
K	14,110	196	2,150	10.4	517.7	517.7	517.7	0.0
L	15,410	513	2,565	8.7	523.5	523.5	524.0	0.5

[1]Feet Above Downstream Limit of Detailed Study

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOODWAY DATA

COW CREEK (NEAR MILLVILLE)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Cow Creek (Near Palo Cedro)								
A	0	831	8,128	6.7	439.8	439.8	440.8	1.0
B	1,500	458	6,466	8.4	441.8	441.8	442.7	0.9
C	1,835	593	7,944	6.8	442.7	442.7	443.4	0.7
D	3,385	1,272	10,691	5.1	444.9	444.9	445.4	0.5
E	4,860	1,090	9,540	5.7	446.7	446.7	447.3	0.6
F	6,110	686	4,636	7.4	451.4	451.4	452.0	0.6

[1] Feet Above Downstream Limit of Detailed Study

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOODWAY DATA

COW CREEK (NEAR PALO CEDRO)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
						(FEET NGVD)		
Dry Creek								
A	0	51	465	6.3	509.9	509.9	510.9	1.0
B	650	64	446	6.5	512.3	512.3	512.8	0.5
C	864	109	531	5.5	513.3	513.3	514.1	0.8
D	1,164	199	891	3.3	514.3	514.3	514.8	0.5
E	1,764	139	491	5.9	516.2	516.2	516.7	0.5
F	2,264	140	582	5.0	517.8	517.8	518.4	0.6
G	3,114	168	554	5.3	520.3	520.3	520.6	0.3
H	3,634	140	649	4.5	522.8	522.8	522.8	0.0
I	4,234	144	617	3.3	524.8	524.8	524.9	0.1
J	4,784	116	486	4.2	526.3	526.3	526.8	0.5
K	4,964	225	782	2.6	526.7	526.7	527.3	0.6
L	5,764	127	437	4.7	528.7	528.7	528.8	0.1
M	5,808	260	751	2.7	528.7	528.7	529.7	1.0
N	6,238	105	402	5.1	530.3	530.3	530.5	0.2
O	7,538	153	402	5.1	536.1	536.1	536.2	0.1
P	9,838	267	563	3.7	546.3	546.3	546.4	0.1
Q	11,338	81	325	6.3	551.8	551.8	552.5	0.7

[1] Feet Above Downstream Limit of Detailed Study

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOODWAY DATA

DRY CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Little Cow Creek								
A	3,510	401	4,406	4.9	446.6	446.6	447.4	0.8
B	5,034	429	4,295	5.0	448.7	448.7	449.3	0.6
C	6,334	454	4,433	4.8	450.8	450.8	451.2	0.4

[1]Feet Above Confluence With Cow Creek (Near Palo Cedro)

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOODWAY DATA

LITTLE COW CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
						(FEET NGVD)		
Sacramento River								
A	500	679	10,471	10.7	412.3	412.3	412.8	0.5
B	1,750	539	9,573	11.7	413.1	413.1	413.9	0.8
C	2,050	561	10,271	10.9	413.2	413.2	414.0	0.8
D	3,860	590	10,404	10.8	415.5	415.5	415.9	0.4
E	4,850	541	9,840	11.4	416.2	416.2	416.7	0.5
F	6,330	536	12,447	9.0	418.4	418.4	418.7	0.3
G	7,130	573	12,609	8.9	418.8	418.8	419.1	0.3
H	8,130	729	13,104	8.5	419.3	419.3	419.7	0.4
I	10,850	723	13,139	8.5	421.6	421.6	421.7	0.1
J	13,970	893	16,297	6.9	425.0	425.0	426.0	1.0
K	19,300	865/615[2]	18,421	6.1	427.0	427.0	428.0	1.0
L	20,410	629/569[2]	16,155	6.9	428.2	428.2	429.1	0.9
M	21,460	594/424[2]	14,904	7.5	429.5	429.5	430.3	0.8
N	25,360	1,167/357[2]	20,373	3.9	433.7	433.7	434.3	0.6
O	27,400	1,364/1,344[2]	13,387	5.9	435.1	435.1	435.6	0.5
P	29,080	445/395[2]	7,044	11.2	437.1	437.1	437.3	0.2
Q	29,590	441/401[2]	7,120	11.1	438.7	438.7	438.7	0.0
R	30,470	613/503[2]	8,772	9.0	441.3	441.3	441.3	0.0
S	31,870	775/705[2]	11,139	7.1	443.4	443.4	443.9	0.5
T	33,050	858/538[2]	11,470	6.9	444.9	444.9	445.6	0.7
U	34,270	415/75[2]	10,556	7.5	446.5	446.5	447.4	0.9
V	34,720	961/201[2]	15,335	5.2	447.0	447.0	448.0	1.0
W	36,720	1,251/81[2]	15,270	5.2	449.9	449.9	450.8	0.9
X	48,320	731/441[2]	13,598	5.8	462.0	462.0	462.6	0.6
Y	49,020	395/255[2]	9,346	8.5	463.0	463.0	463.7	0.7

[1]Feet Above Downstream Limit of Detailed Study [2]Width/Width Within County Limits

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOODWAY DATA

SACRAMENTO RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Sacramento River (Cont'd)								
Z	81,352	313/263[2]	8,339	9.5	503.9	503.9	504.6	0.7
AA	82,202	398	8,628	9.2	505.2	505.2	505.9	0.7

[1]Feet Above Downstream Limit of Detailed Study [2]Width/Width Within County Limits

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOODWAY DATA

SACRAMENTO RIVER

some floodway reaches were modified to conform to the revised 100-year boundaries developed using historic high-water mark data.

No floodway data are shown for Tormey Drain because no cross sections lie within the unincorporated areas of the county.

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 3.

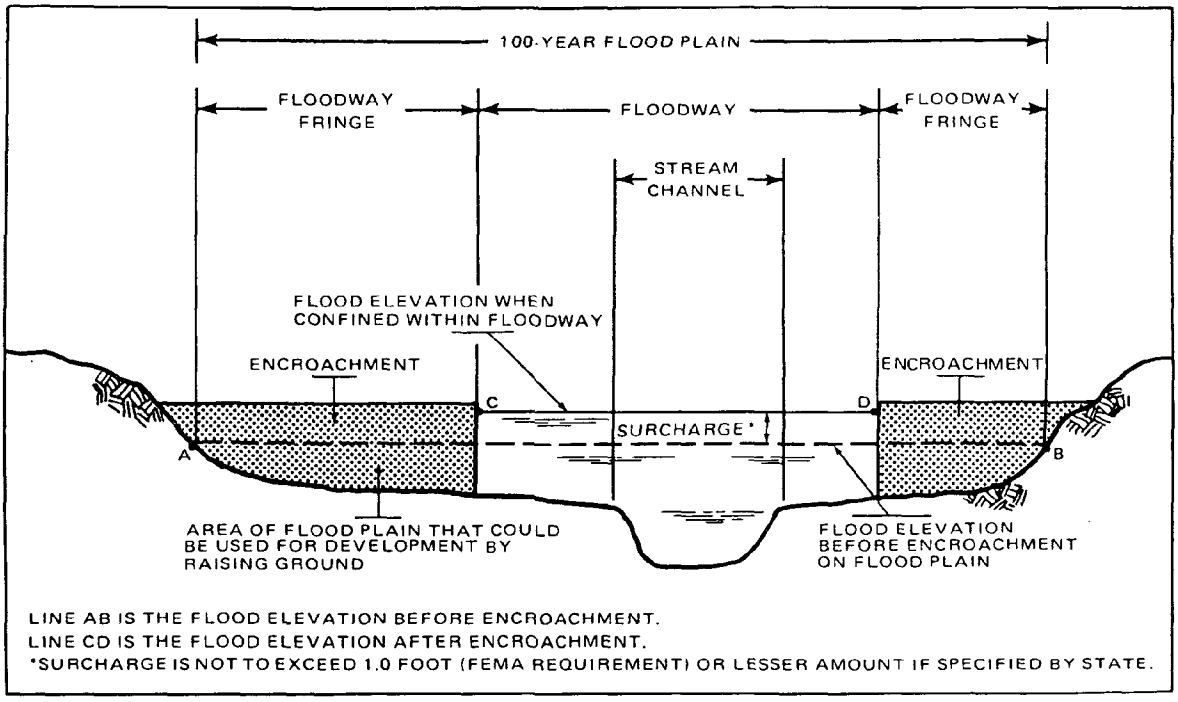

Figure 3. Floodway Schematic

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the Federal Emergency Management Agency has developed a process to transform the data from the

engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting the unincorporated areas of Shasta County.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of Shasta County are shown on the Flood Profiles (Exhibit 1) and summarized in Table 5.

5.2 Flood Hazard Factors (FHFs)

The FHF is the Federal Emergency Management Agency device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest one-half foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire unincorporated area of Shasta County was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Burney Creek							
Reach 1	0405	-1.0	-0.1	0.3	010	A2	Varies - See Map
Reach 2	0405	-4.1	-1.1	1.5	040	A8	Varies - See Map
Reach 3	0405	-5.6	-1.9	2.2	055	A11	Varies - See Map
Reach 4	0405	-7.9	-4.2	5.2	080	A16	Varies - See Map
Reach 5	0405	-4.8	-2.8	5.2	050	A10	Varies - See Map
Reach 6	0405	-2.3	-1.4	4.3	025	A5	Varies - See Map
Burney Creek West Branch							
Reach 1	0405	-1.4	-0.5	1.1	015	A3	Varies - See Map
Reach 2	0405	-3.7	-1.0	1.5	035	A7	Varies - See Map
Reach 3	0405	-4.1	-1.1	1.5	040	A8	Varies - See Map
Churn Creek							
Reach 1	0685,0695	-2.0	-0.5	1.2	020	A4	Varies - See Map
Reach 2	0680,0685	-1.3	-0.6	0.9	015	A3	Varies - See Map
Clover Creek							
Reach 1	0715	-3.0	-0.9	1.9	030	A6	Varies - See Map
Cow Creek (Near Millville)							
Reach 1	0715	-2.5	-0.7	1.8	025	A5	Varies - See Map

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD INSURANCE ZONE DATA

BURNEY CREEK-BURNEY CREEK WEST BRANCH-CHURN CREEK-CLOVER CREEK-COW CREEK (NEAR MILLVILLE)

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Cow Creek (Near Palo Cedro)							
Reach 1	0715	-3.2	-1.0	2.9	030	A6	Varies - See Map
Reach 2	0715	-3.6	-1.0	2.1	035	A7	Varies - See Map
Dry Creek							
Reach 1	0520,0685 0705	-1.1	-0.3	0.8	010	A2	Varies - See Map
Little Cow Creek							
Reach 1	0715	-3.6	-0.8	3.1	035	A7	Varies - See Map
Sacramento River							
Reach 1	0885	-1.3	-0.5	9.6	015	A3	Varies - See Map
Reach 2	0690,0695 0880,0885	-2.0	-0.8	11.2	020	A4	Varies - See Map
Reach 3	0680,0690 0695	0.0	0.0	14.8	005	A1	Varies - See Map
Tormey Drain							
Reach 1	0885	-0.8	-0.4	3.8	010	A2	Varies - See Map

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD INSURANCE ZONE DATA

COW CREEK (NEAR PALO CEDRO)-DRY CREEK-LITTLE COW CREEK-SACRAMENTO RIVER-TORMEY DRAIN

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A1-A8, A10, A11, and A16:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding.
Zone D:	Areas of undetermined, but possible flood hazard.

The flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the county are summarized in Table 5.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for Shasta County is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the Federal Emergency Management Agency.

6.0 OTHER STUDIES

A Flood Insurance Study is being prepared for the City of Redding (Reference 19). The results of that study match the Shasta County study.

A Flood Insurance Study for the City of Anderson has previously been published (Reference 20). The profiles in that report do not match those in this Flood Insurance Study because the U.S. Army Corps of Engineers revised their flood peak estimates in connection with their study of the Cottonwood Creek hydrology (Reference 4).

Additional reports reviewed and/or utilized for this study included U.S. Army Corps of Engineers Flood Plain Information Reports on Sacramento River, Redding, California (Reference 21); Cow Creek, Palo Cedro, California (Reference 22); Sacramento River and Olinda Creek, Anderson, California (Reference 23); and Churn Creek, Enterprise, California (Reference 2); and Flood Hazard Information Reports on Clover and Stillwater Creeks and Tributaries, Loomis Corners, California (Reference 24), the Cottonwood-Bend Areas, California (Reference 25); Churn Creek (Reference 26); Burney Creek (Reference 27), and Cottonwood Creek (Reference 4). These reports are in general agreement with this Flood Insurance Study.

A Flood Hazard Boundary Map of Shasta County was published in 1977 (Reference 3), but is superseded by this study due to the more detailed analyses done for this study.

This study is authoritative for the purposes of the National Flood Insurance Program; data presented herein either supersede or are compatible with all previous determinations.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Presidio of San Francisco, Building 105, San Francisco, California 94129.

8.0 BIBLIOGRAPHY AND REFERENCES

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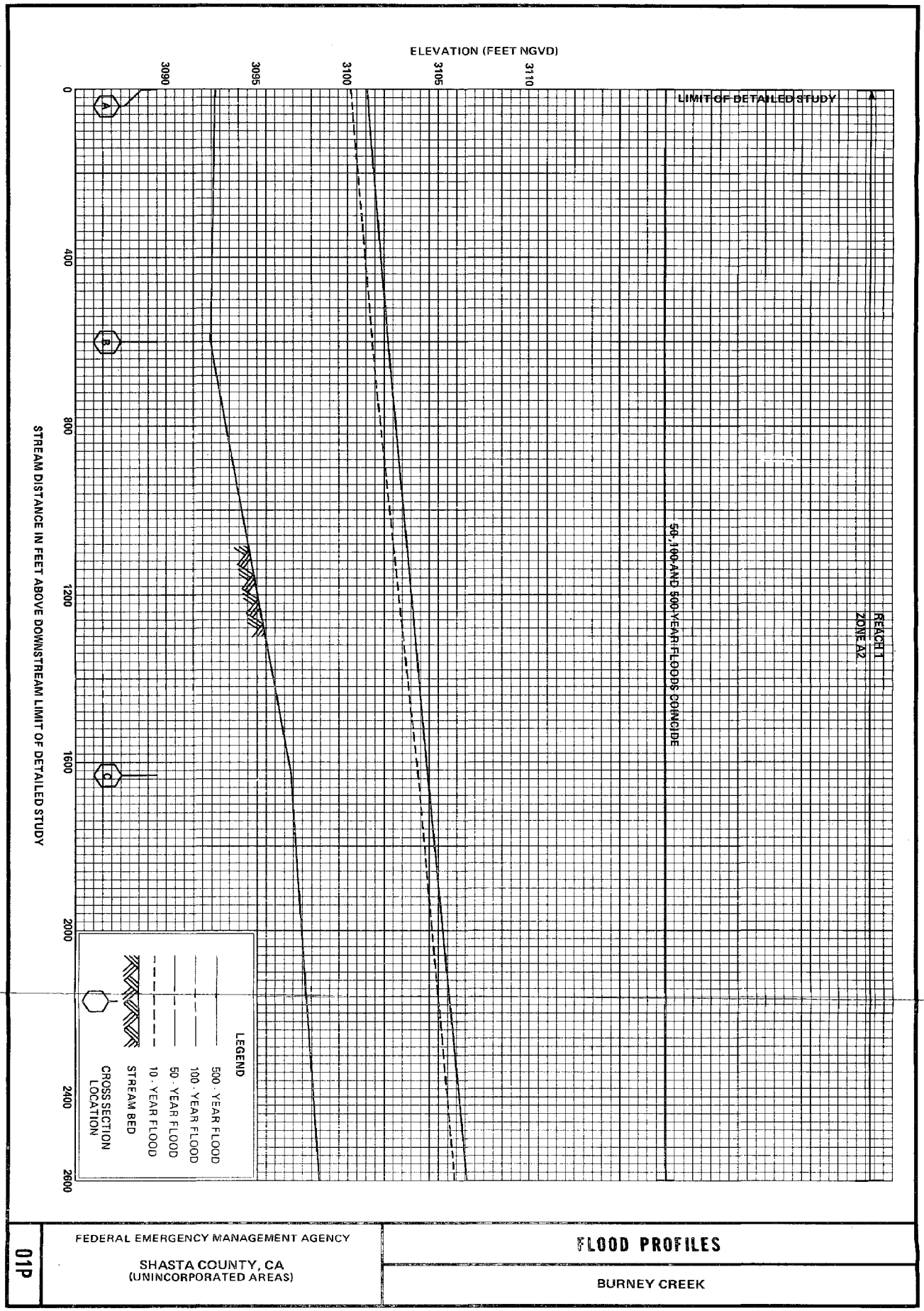


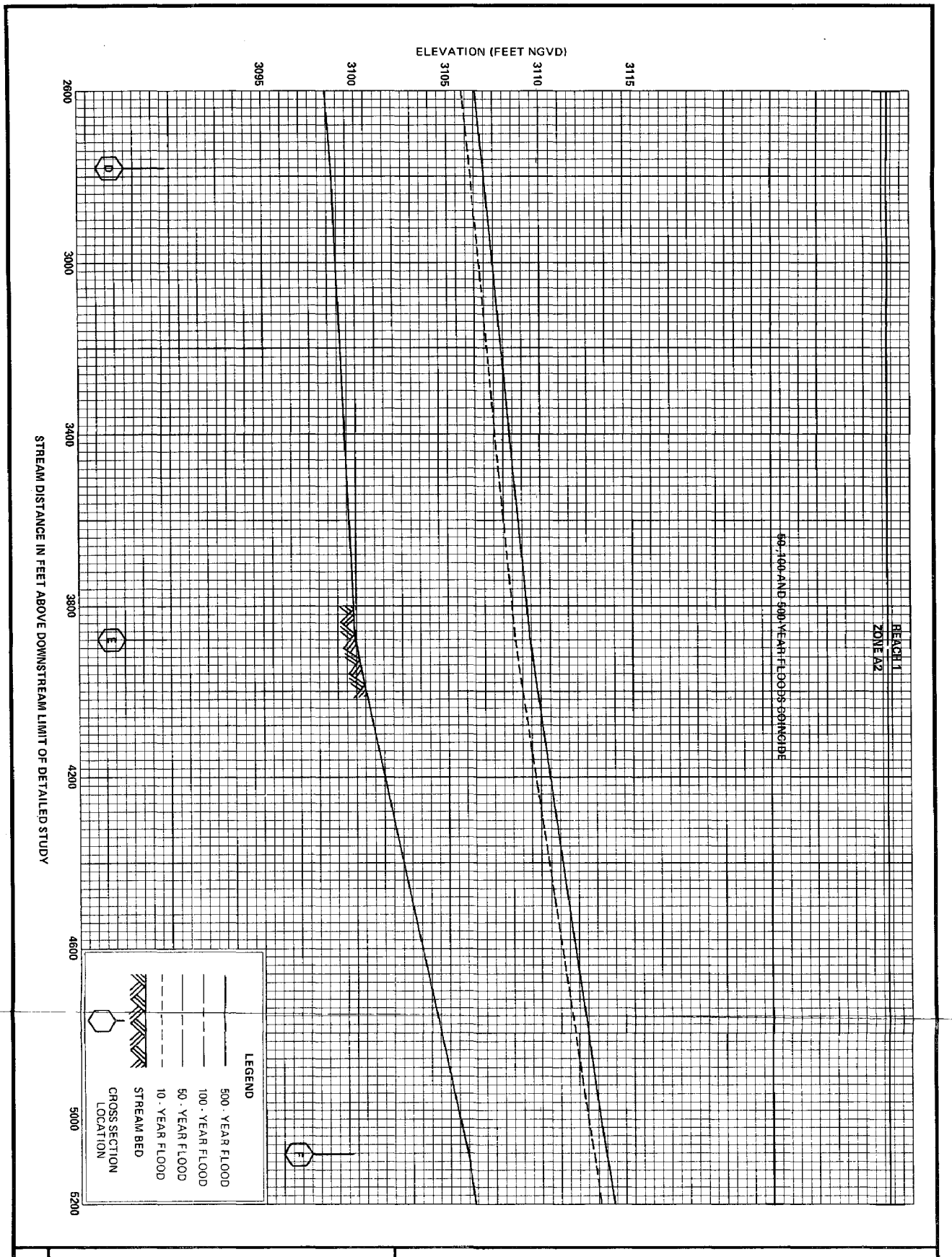
01P

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

BURNEY CREEK



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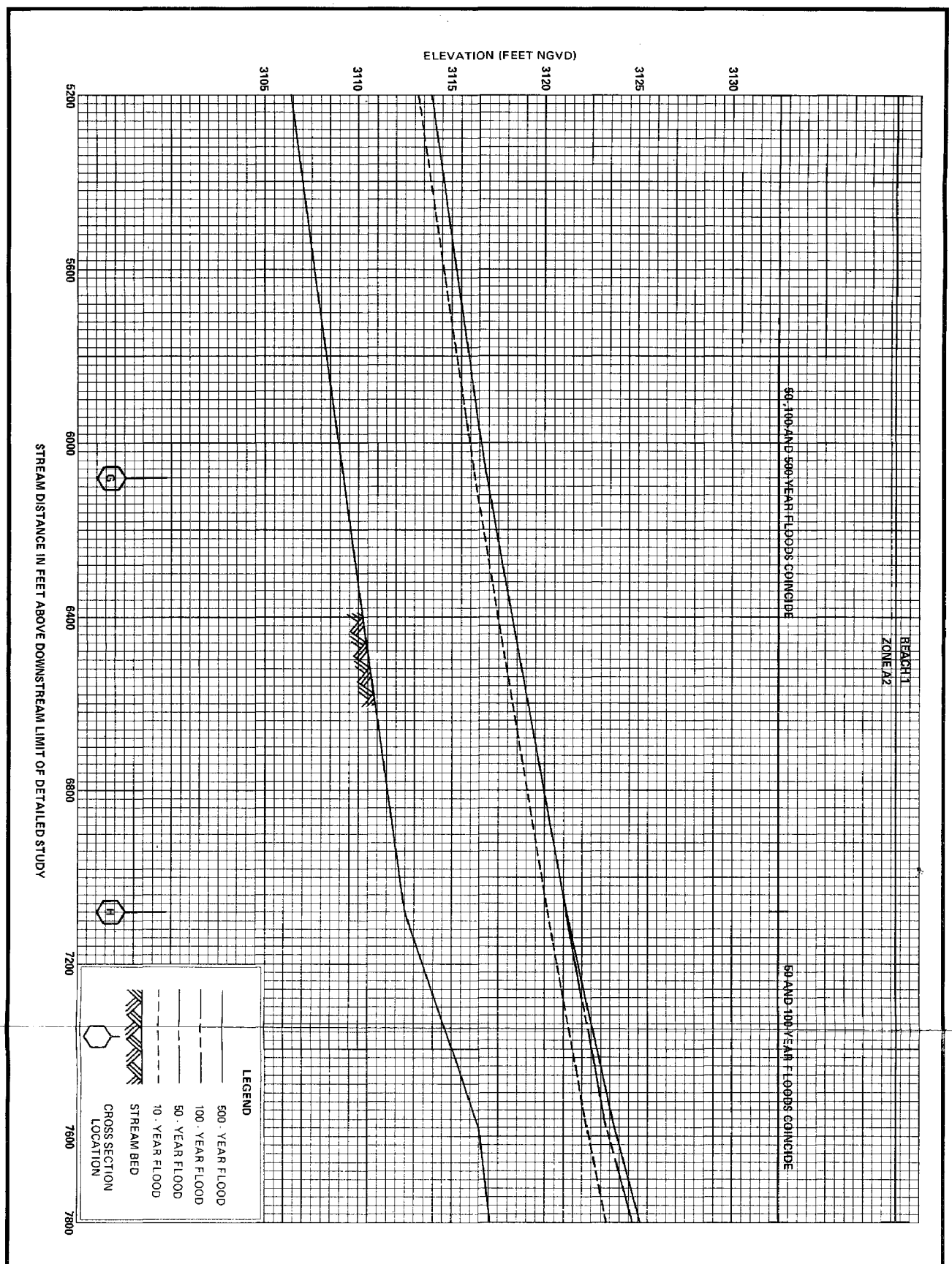
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

BURNEY CREEK



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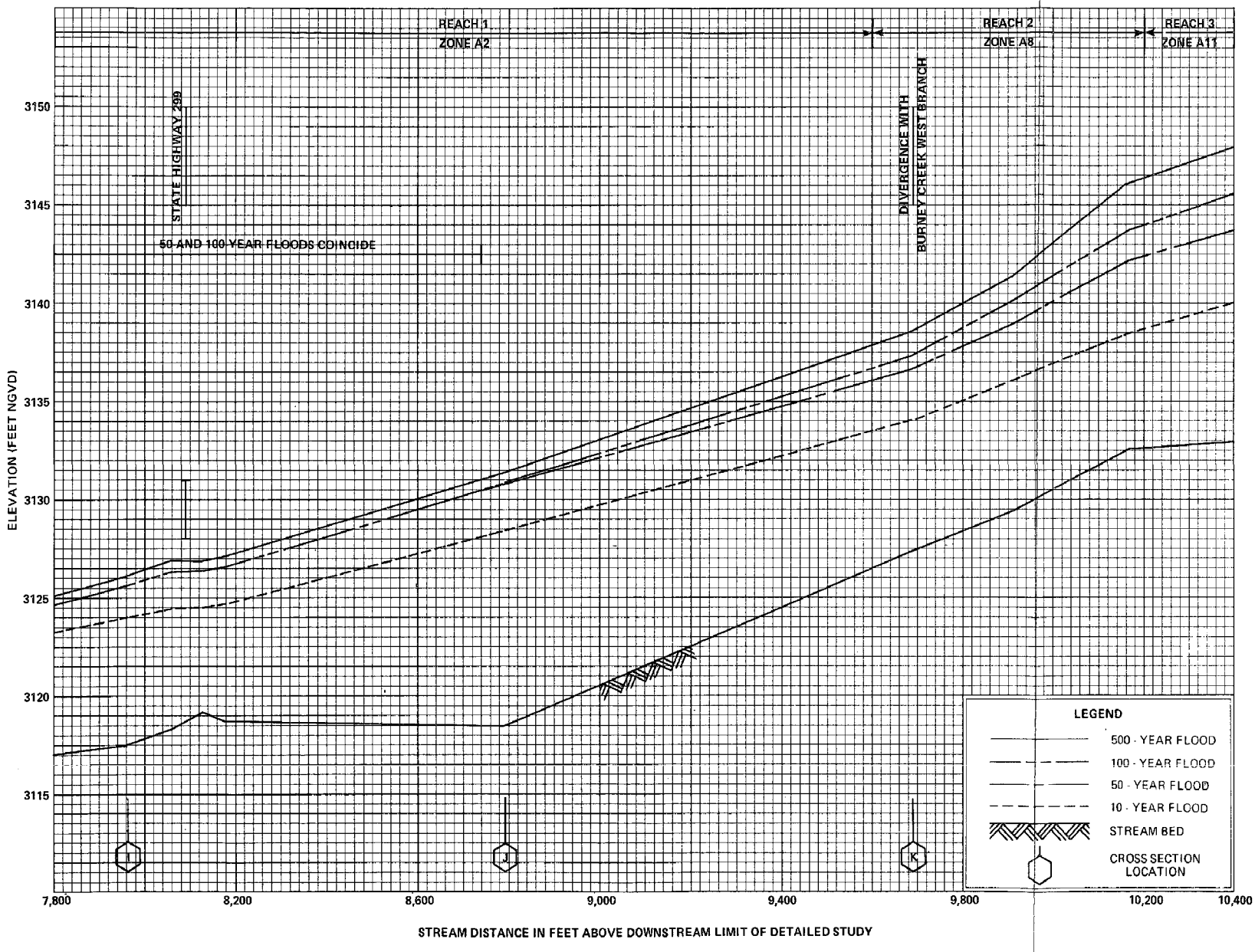


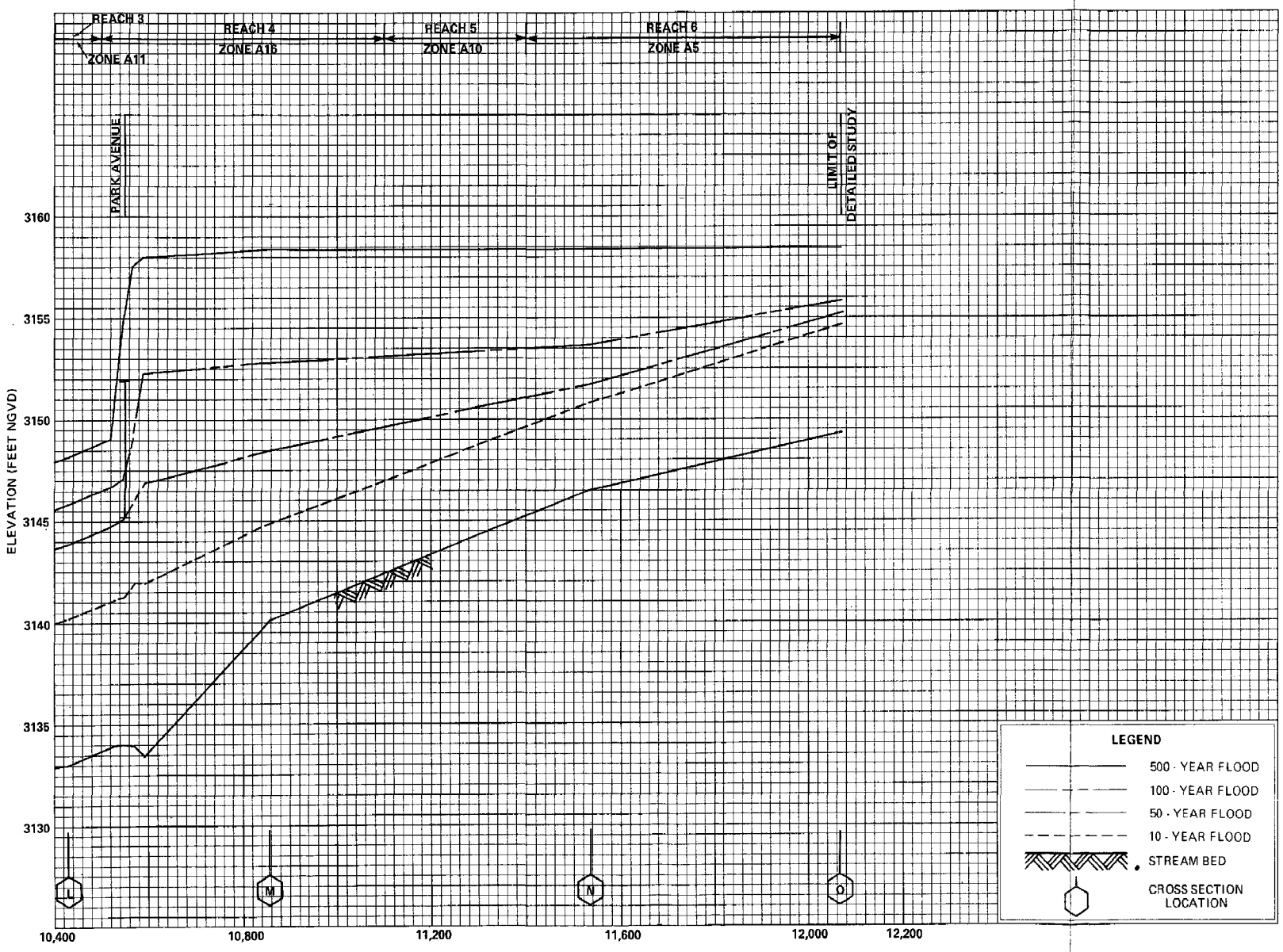
FLOOD PROFILES

BURNEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

04P



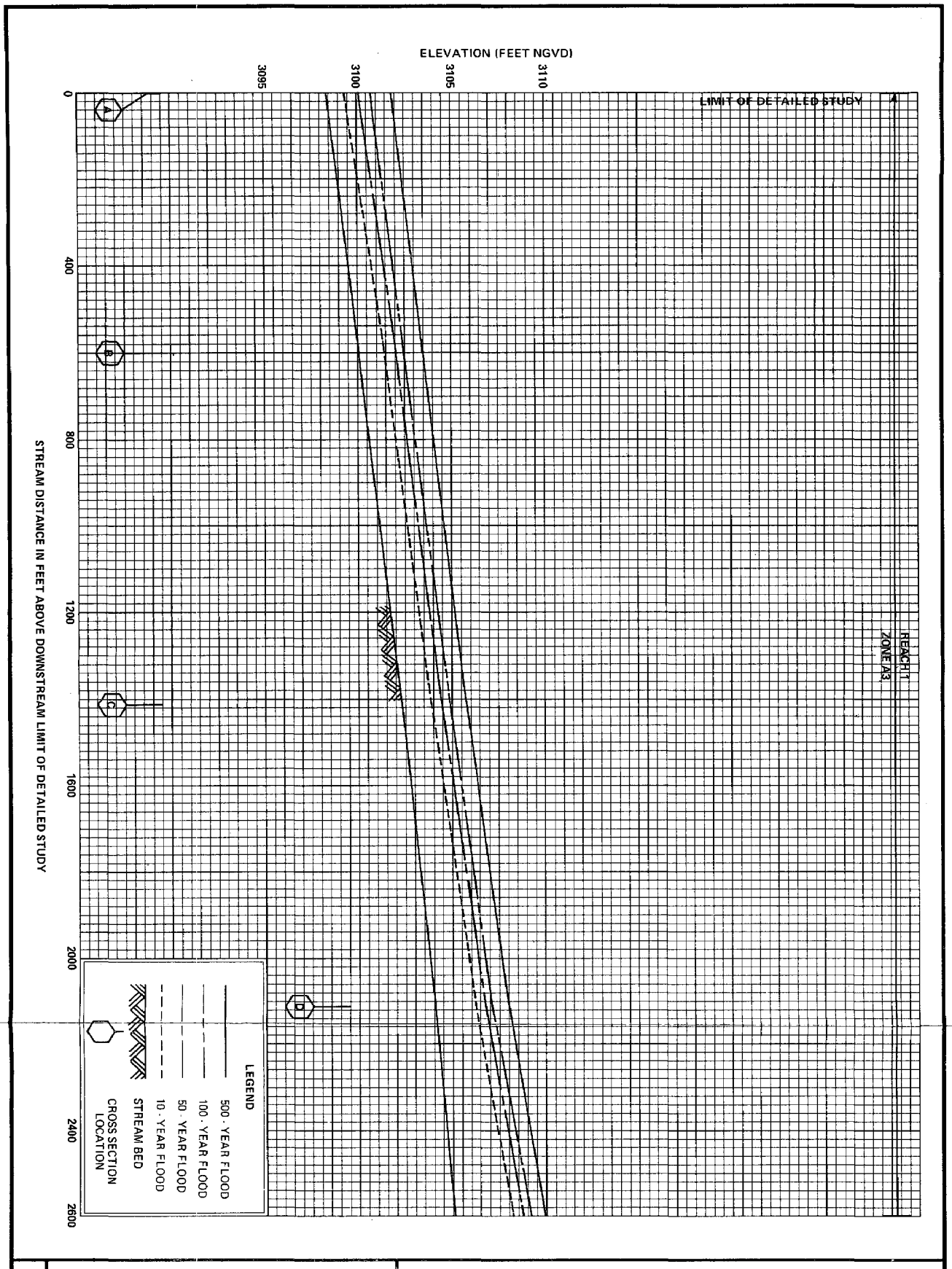
FLOOD PROFILES

BURNEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

05P



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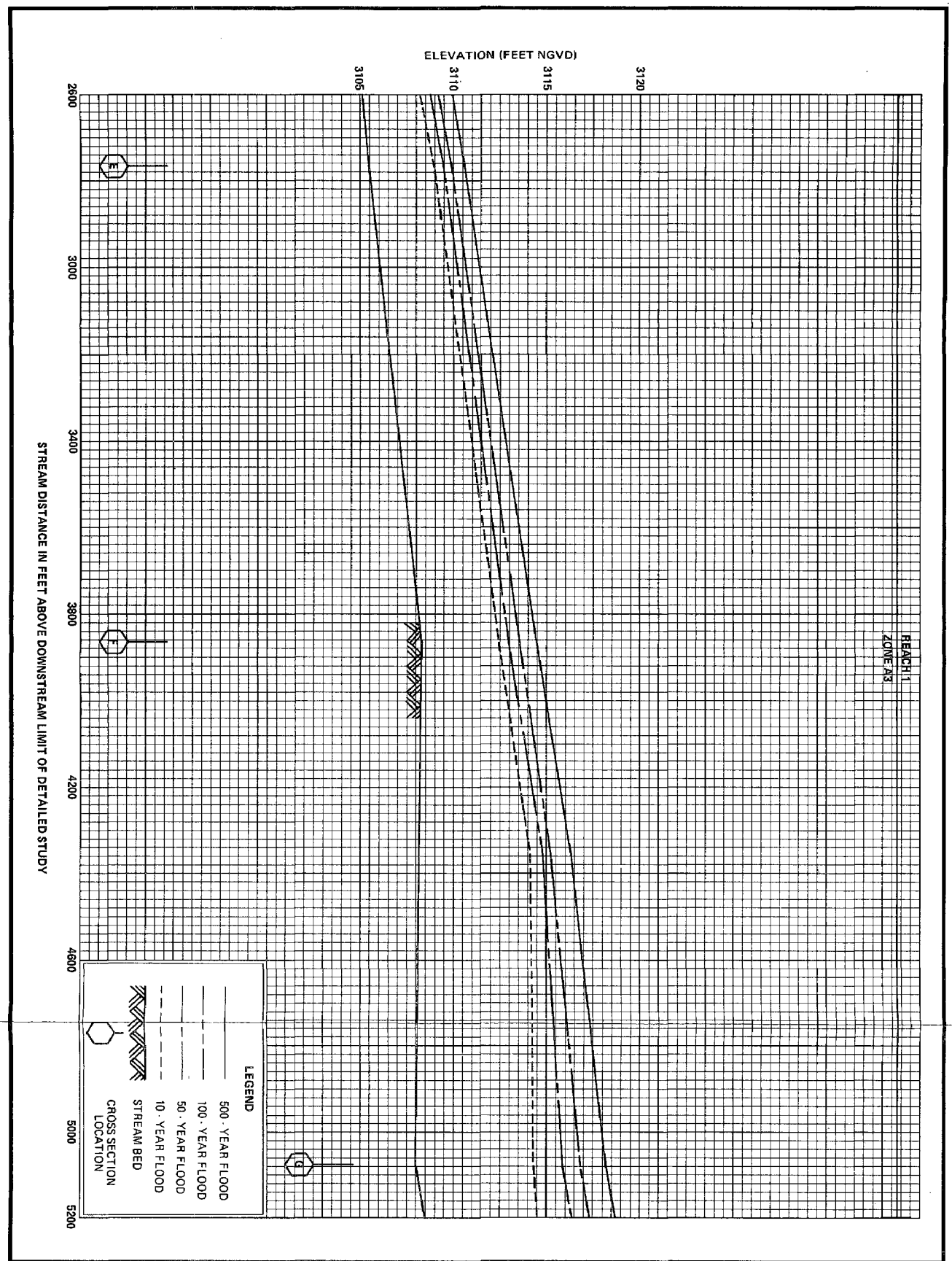
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

BURNEY CREEK WEST BRANCH



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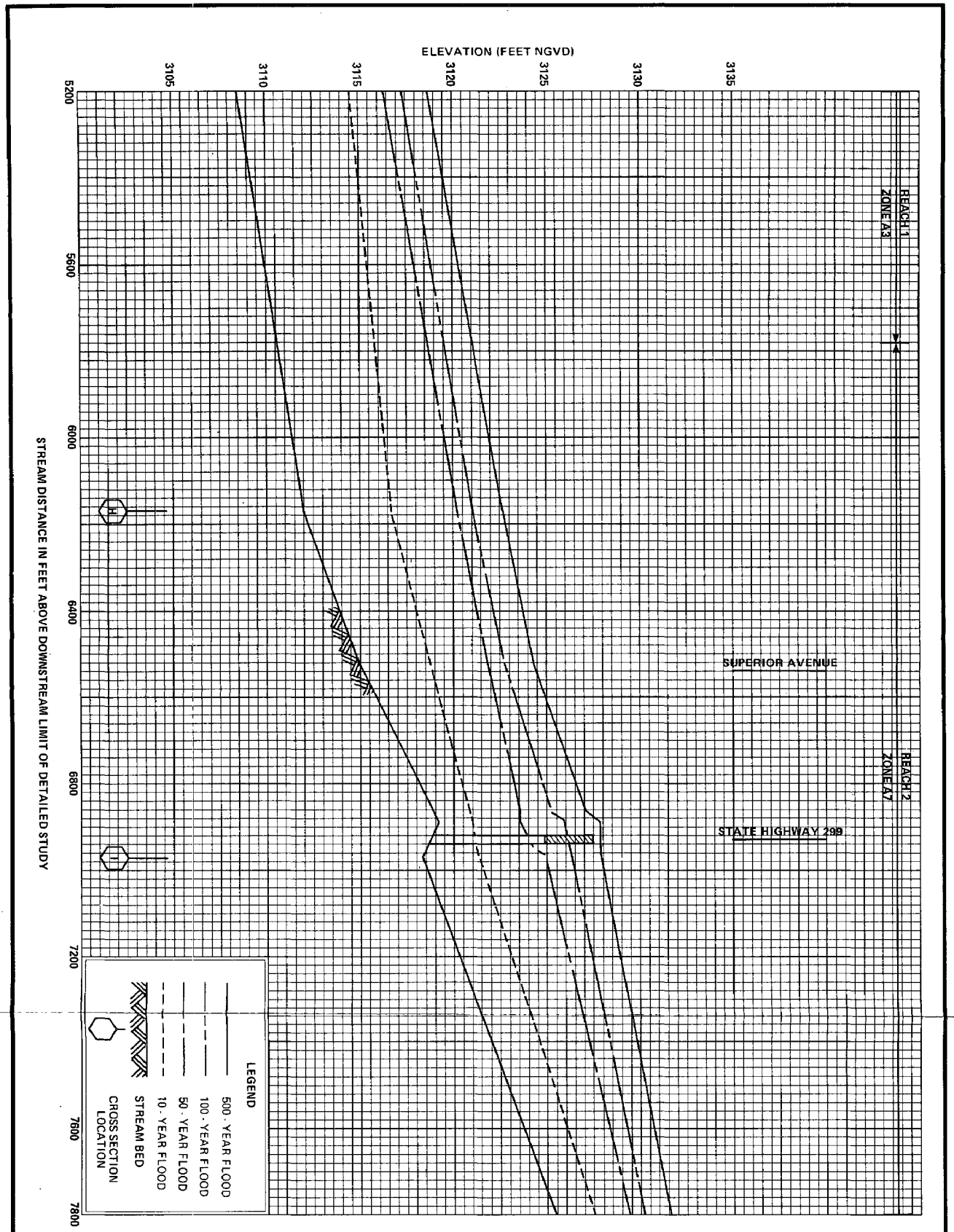
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

BURNEY CREEK WEST BRANCH



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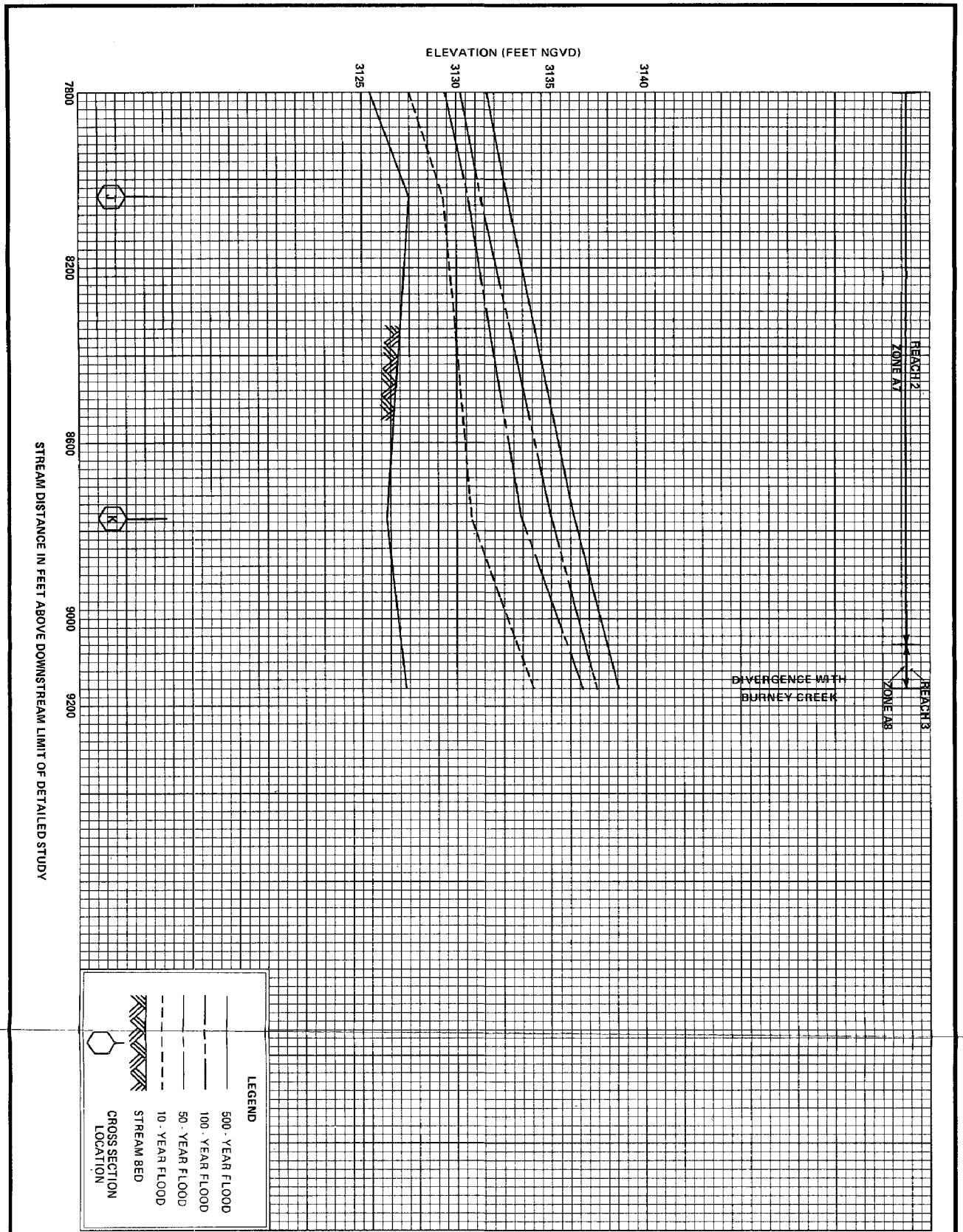

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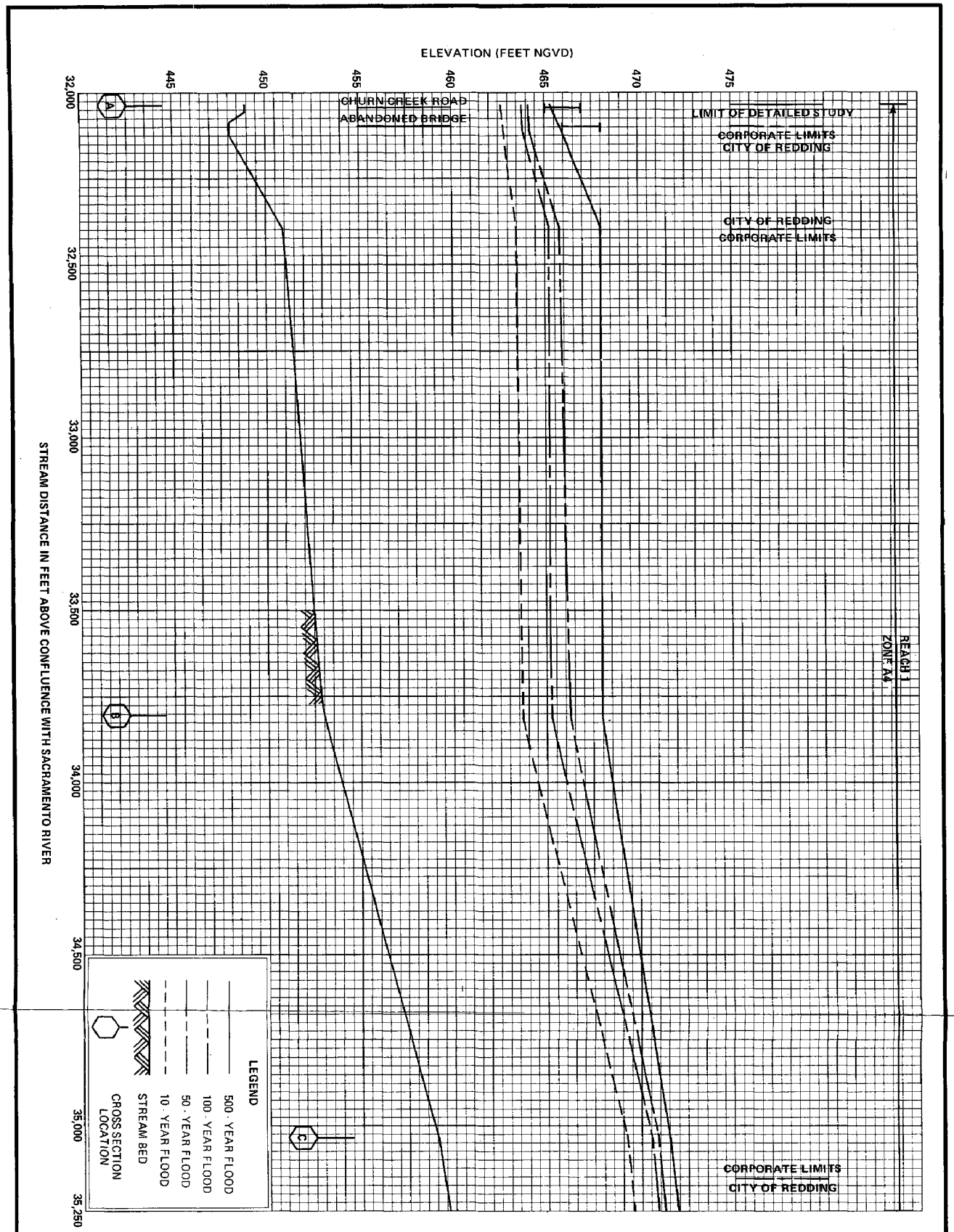
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

BURNEY CREEK WEST BRANCH



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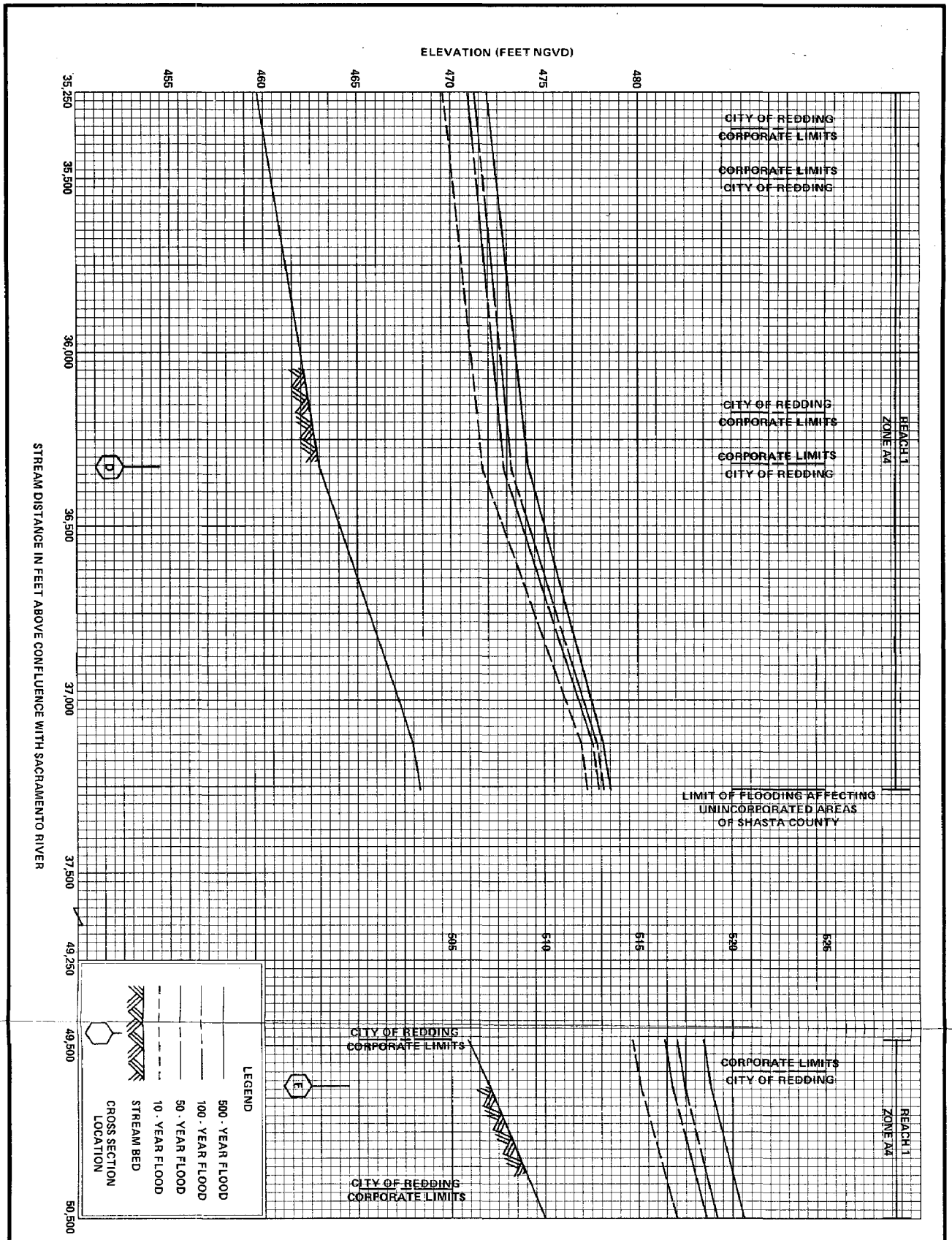
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

CHURN CREEK



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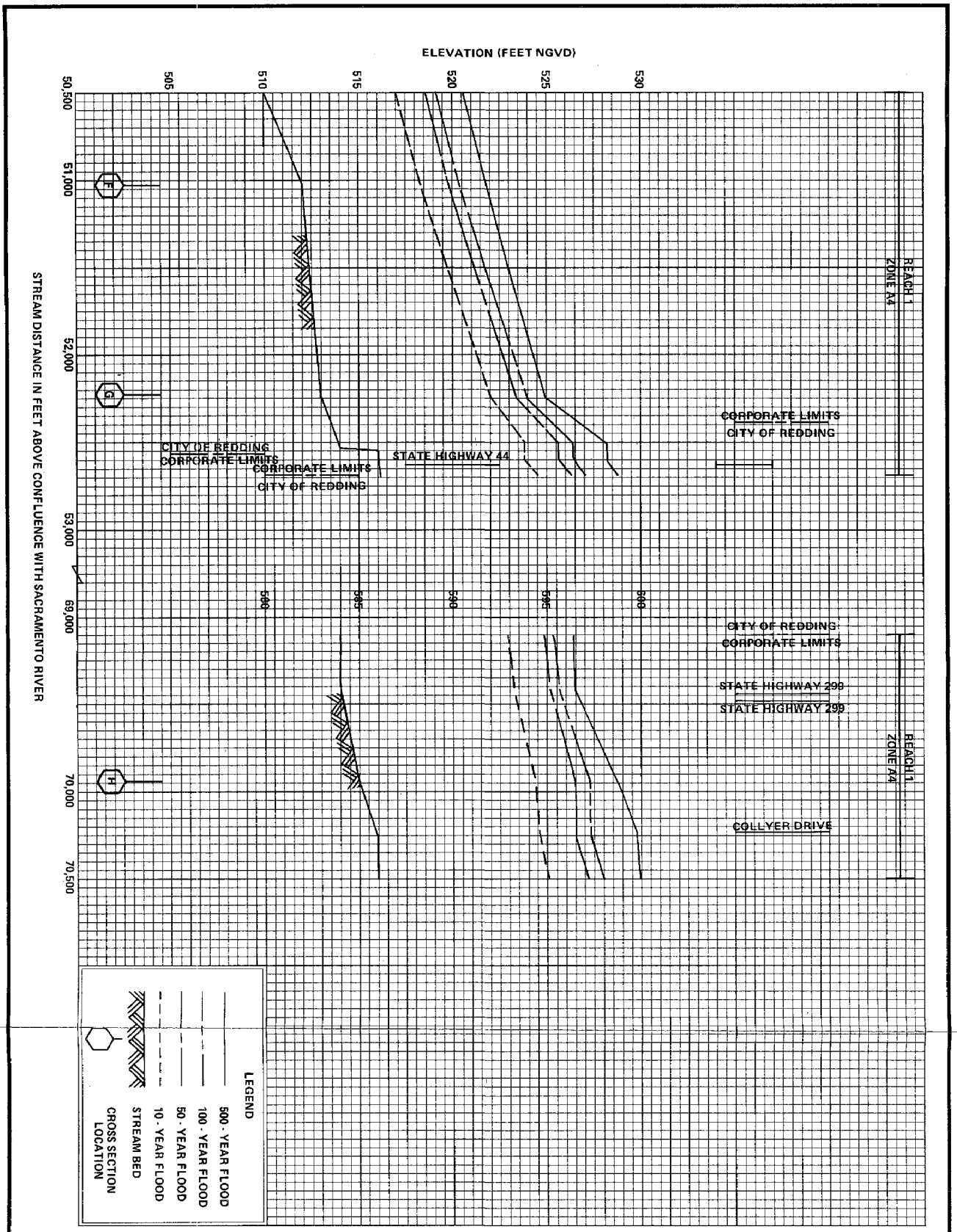

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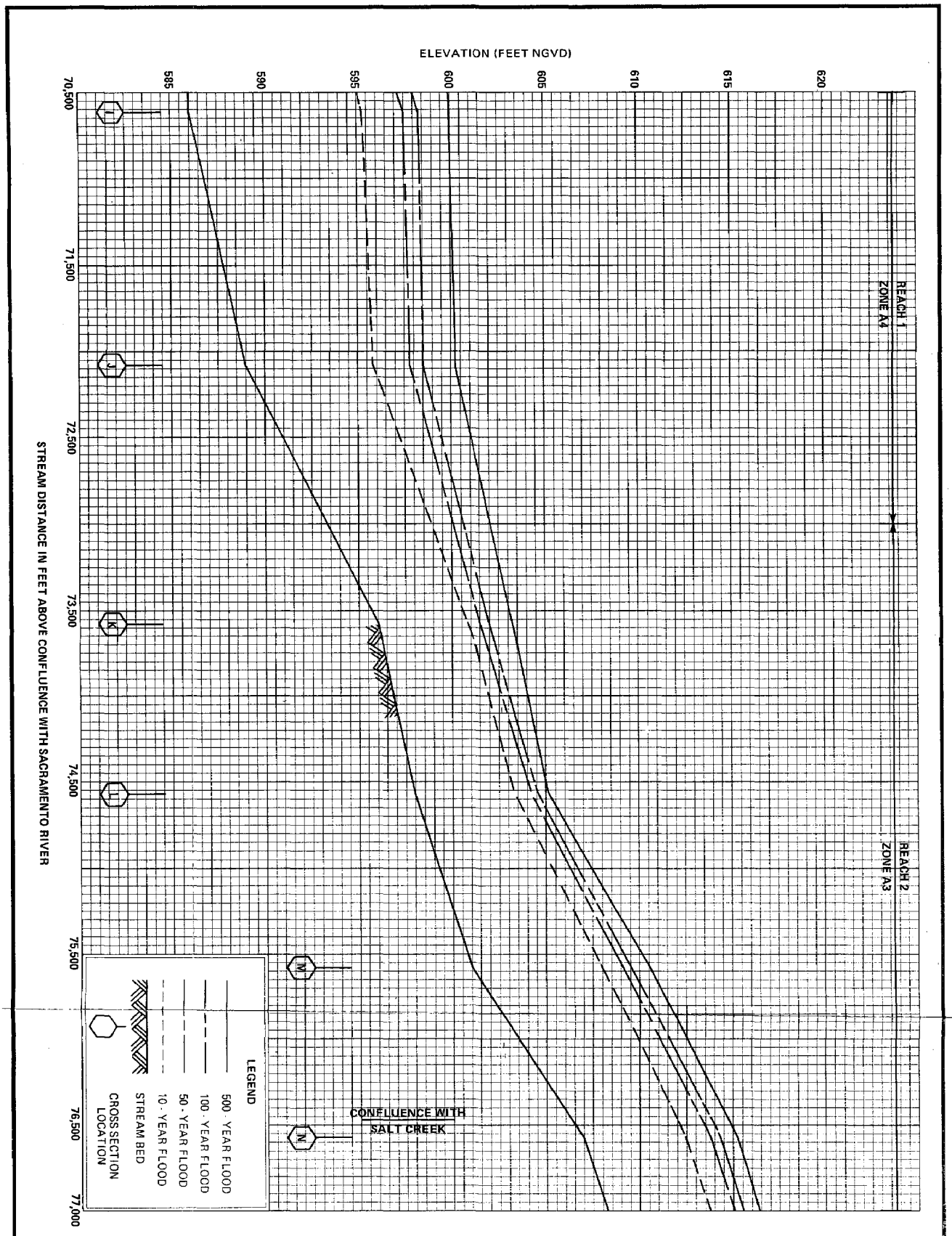
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

CHURN CREEK



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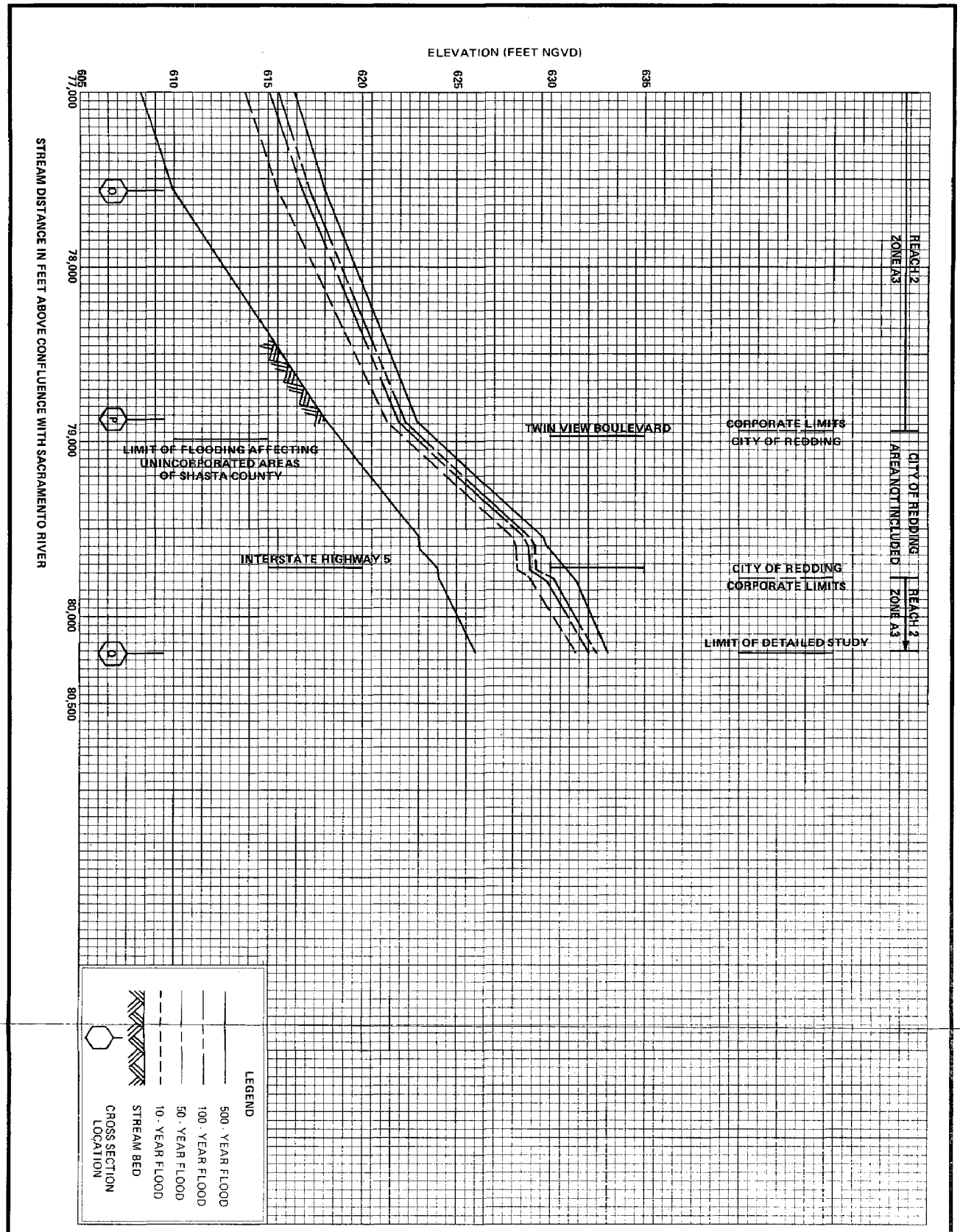

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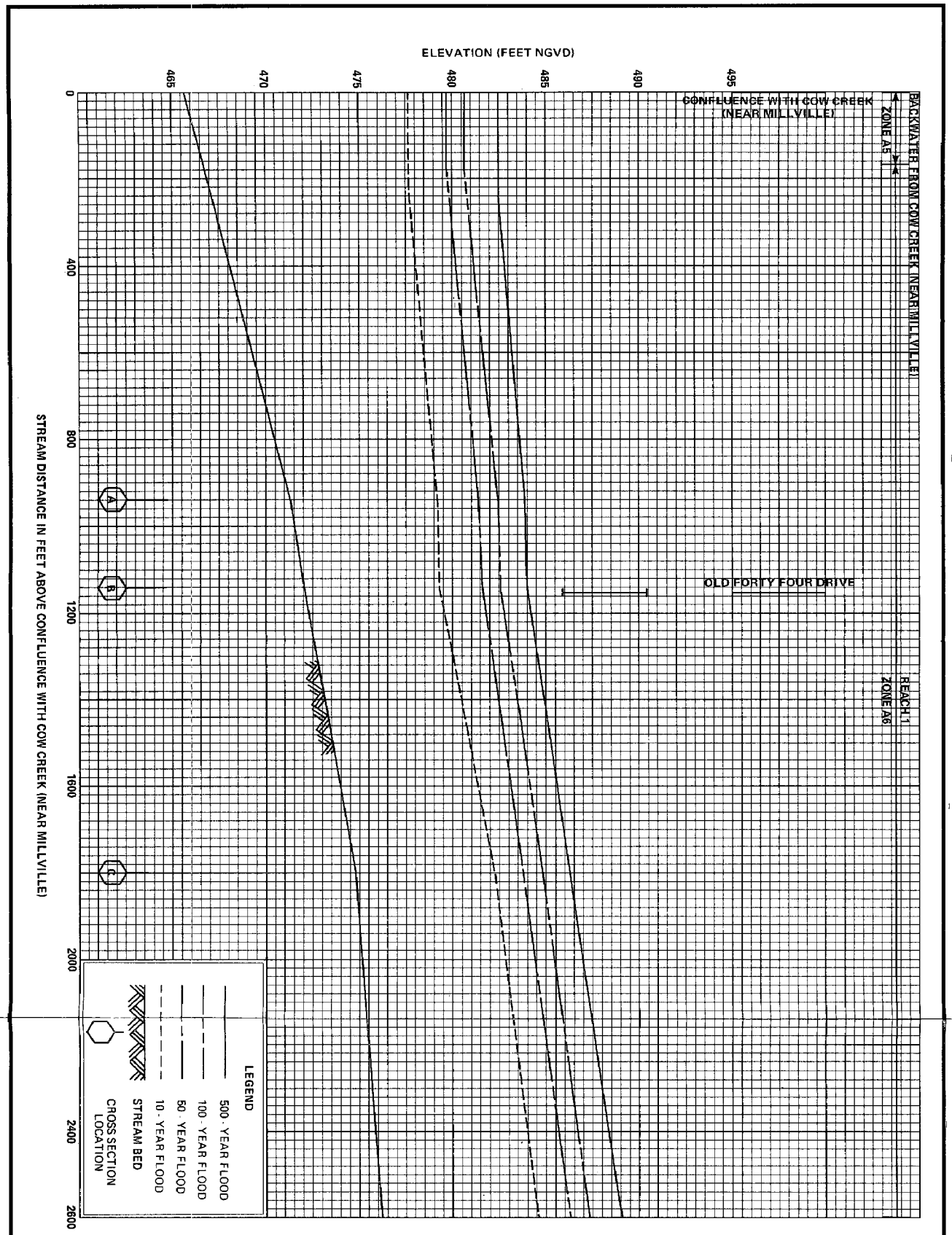
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

CHURN CREEK



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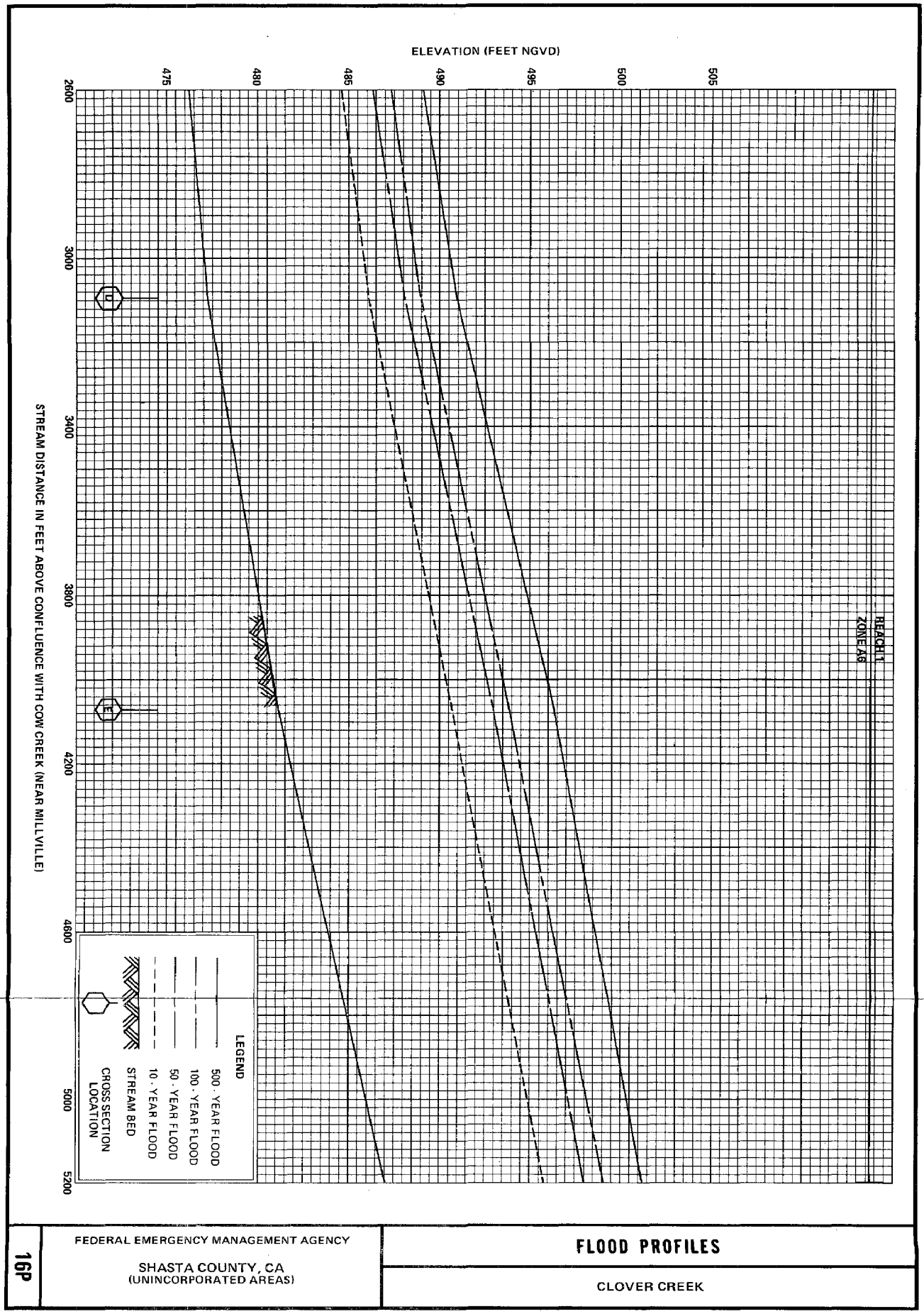

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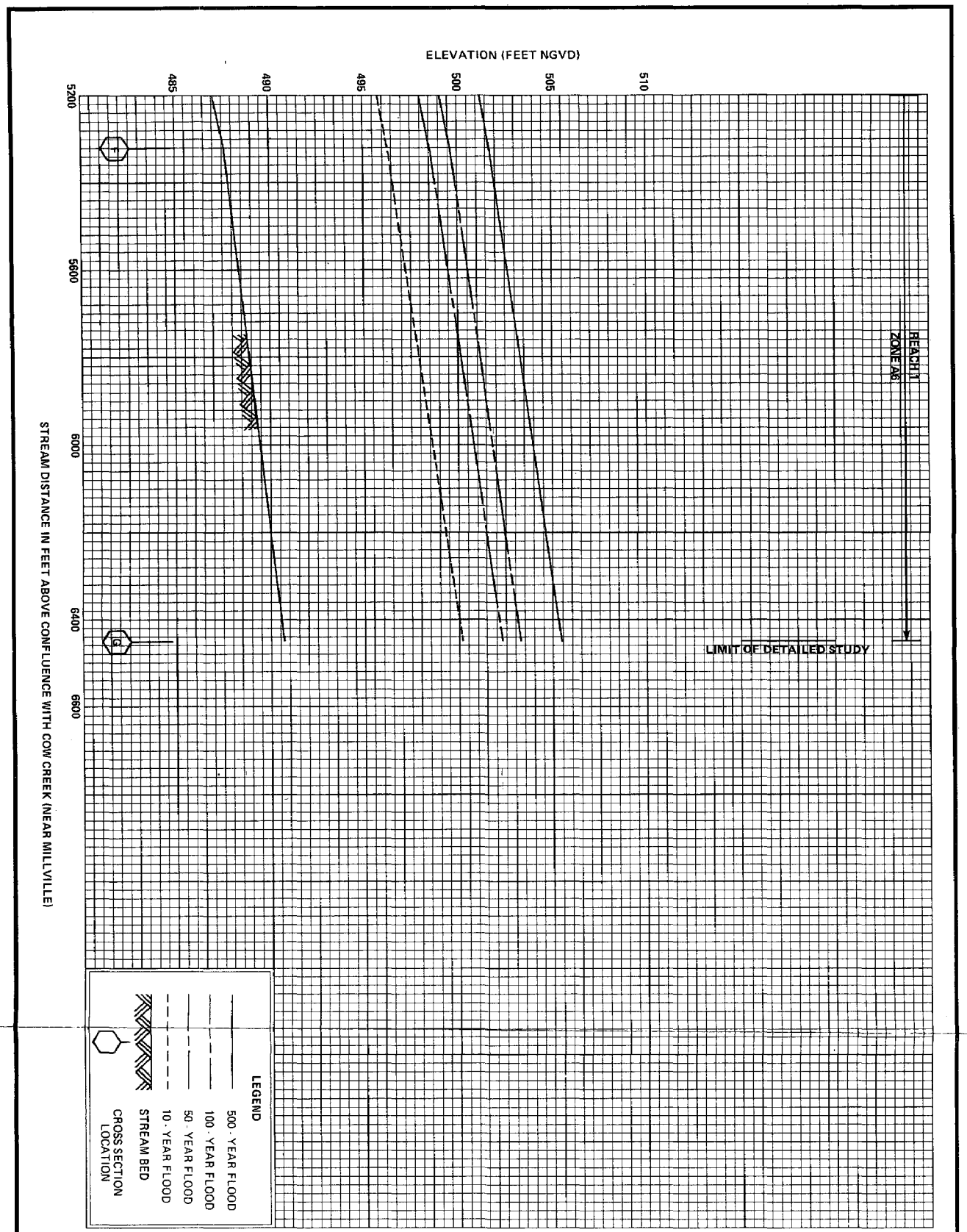
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

CLOVER CREEK



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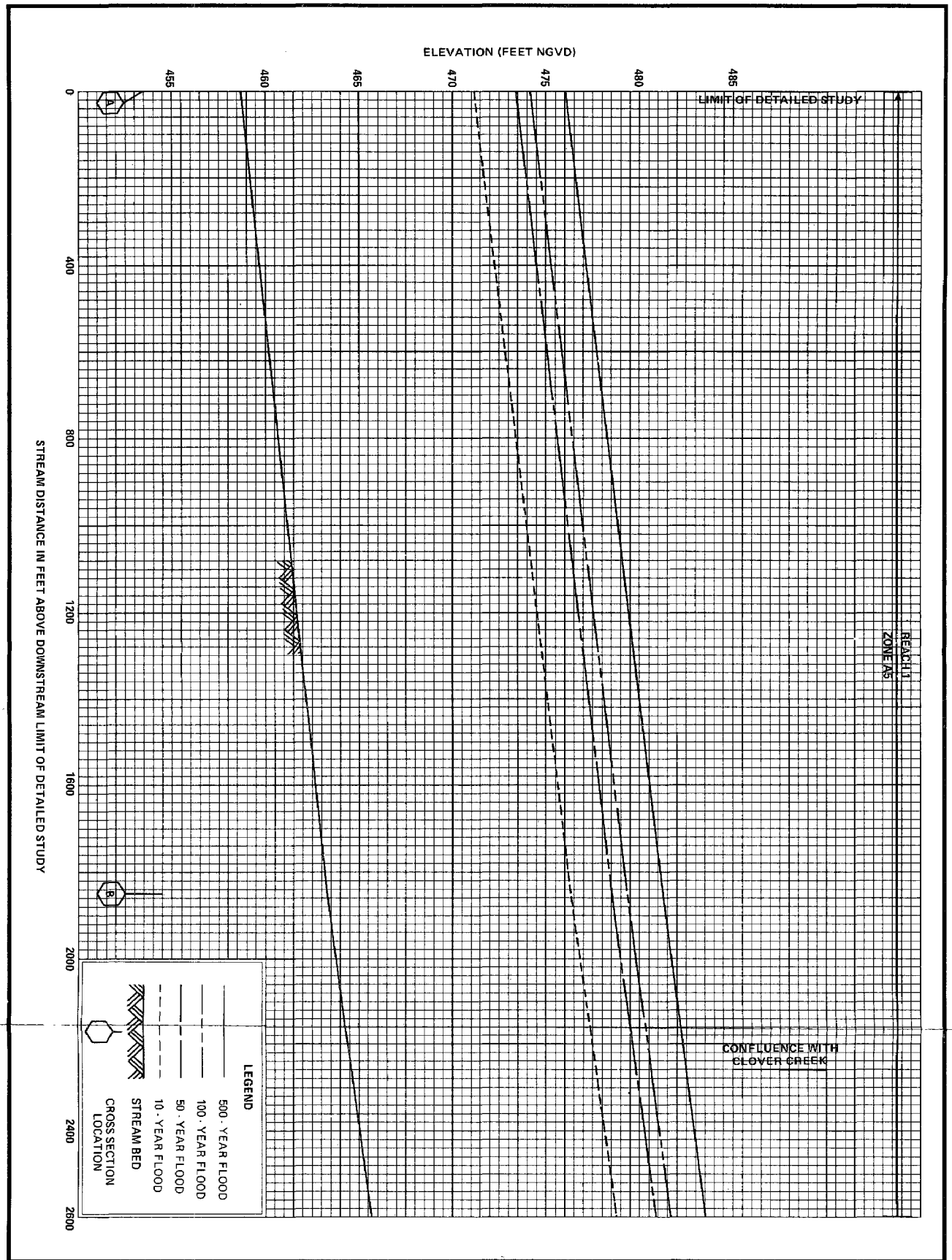

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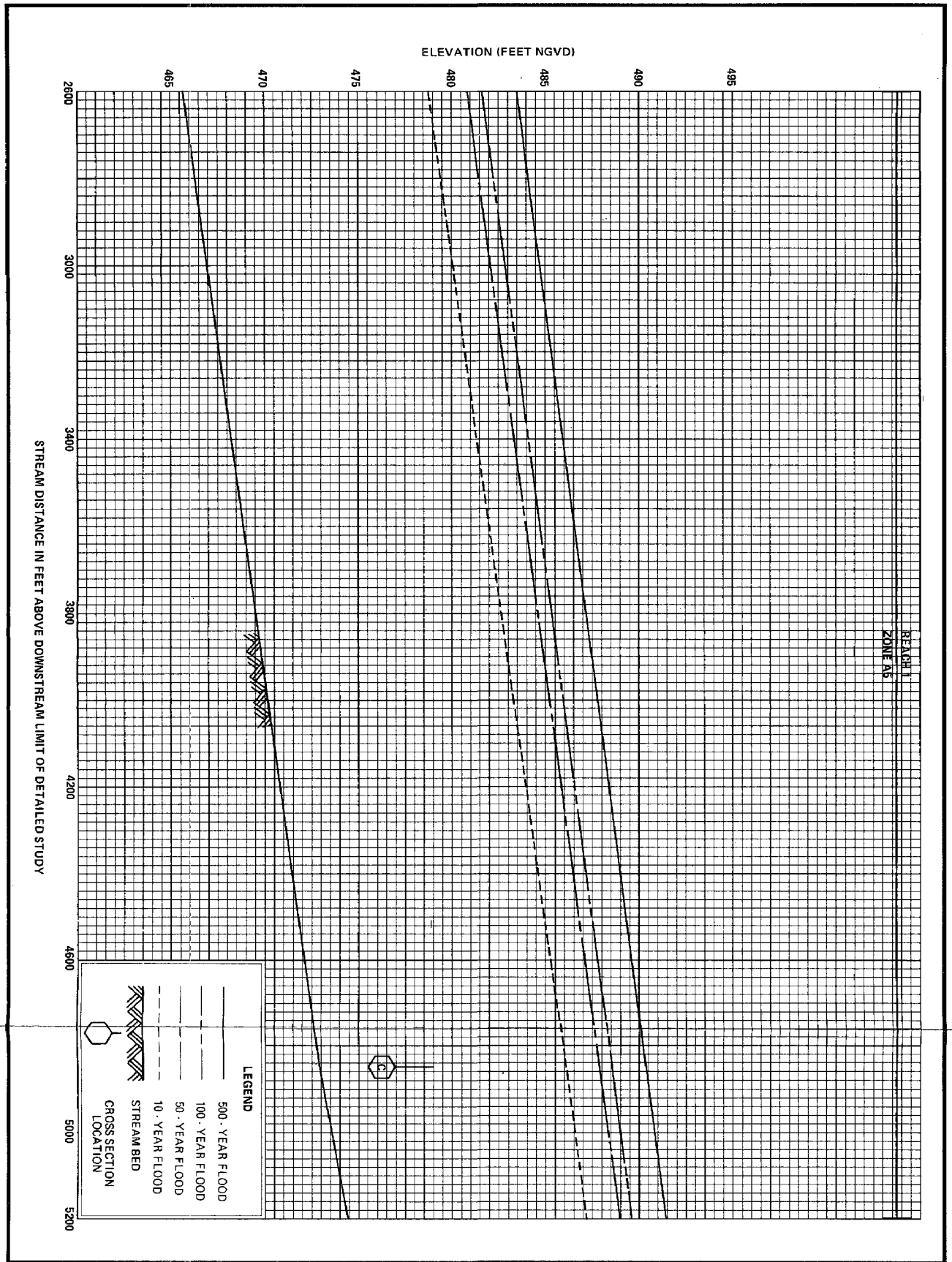
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

COW CREEK (NEAR MILLVILLE)



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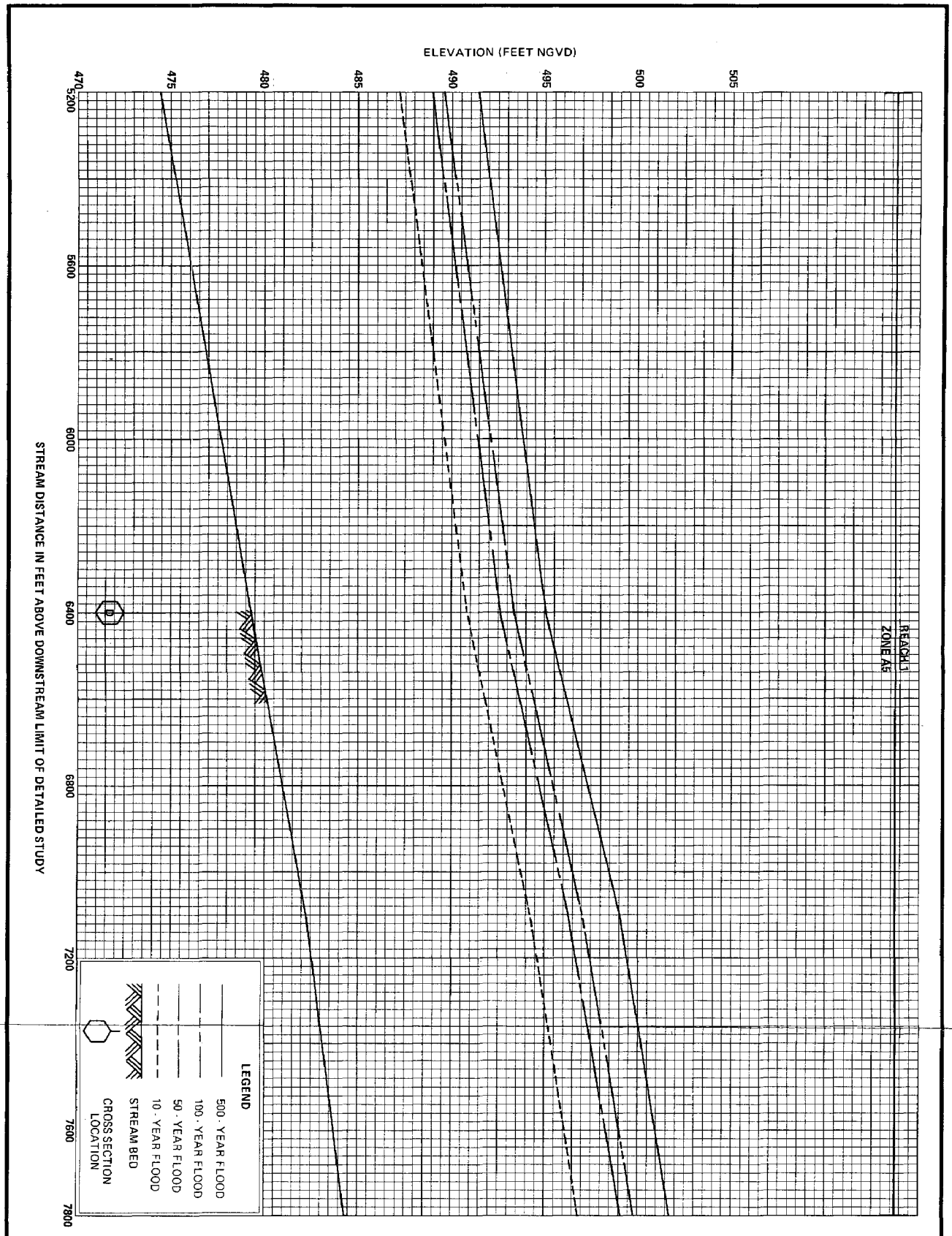
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

COW CREEK (NEAR MILLVILLE)



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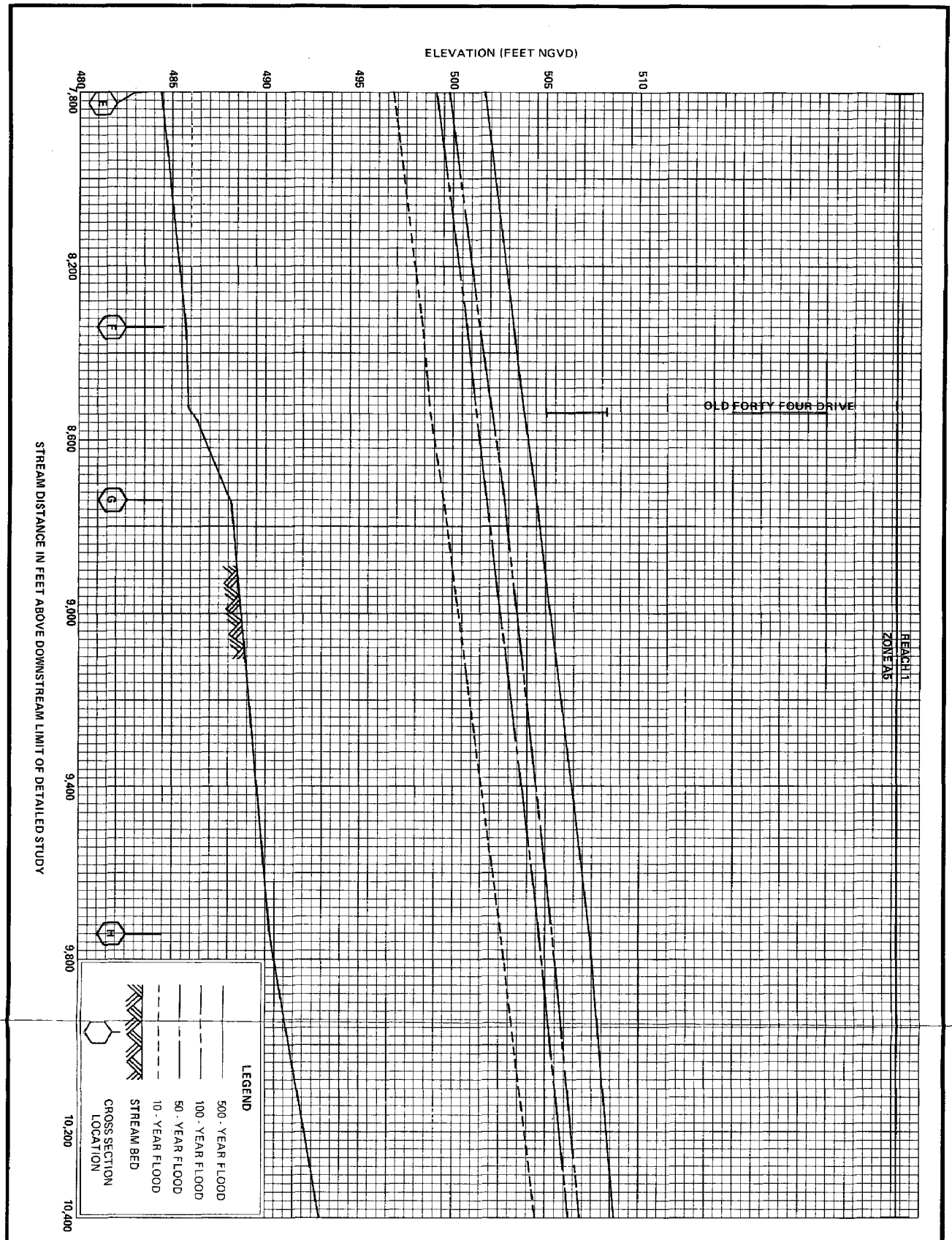
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

COW CREEK (NEAR MILLVILLE)



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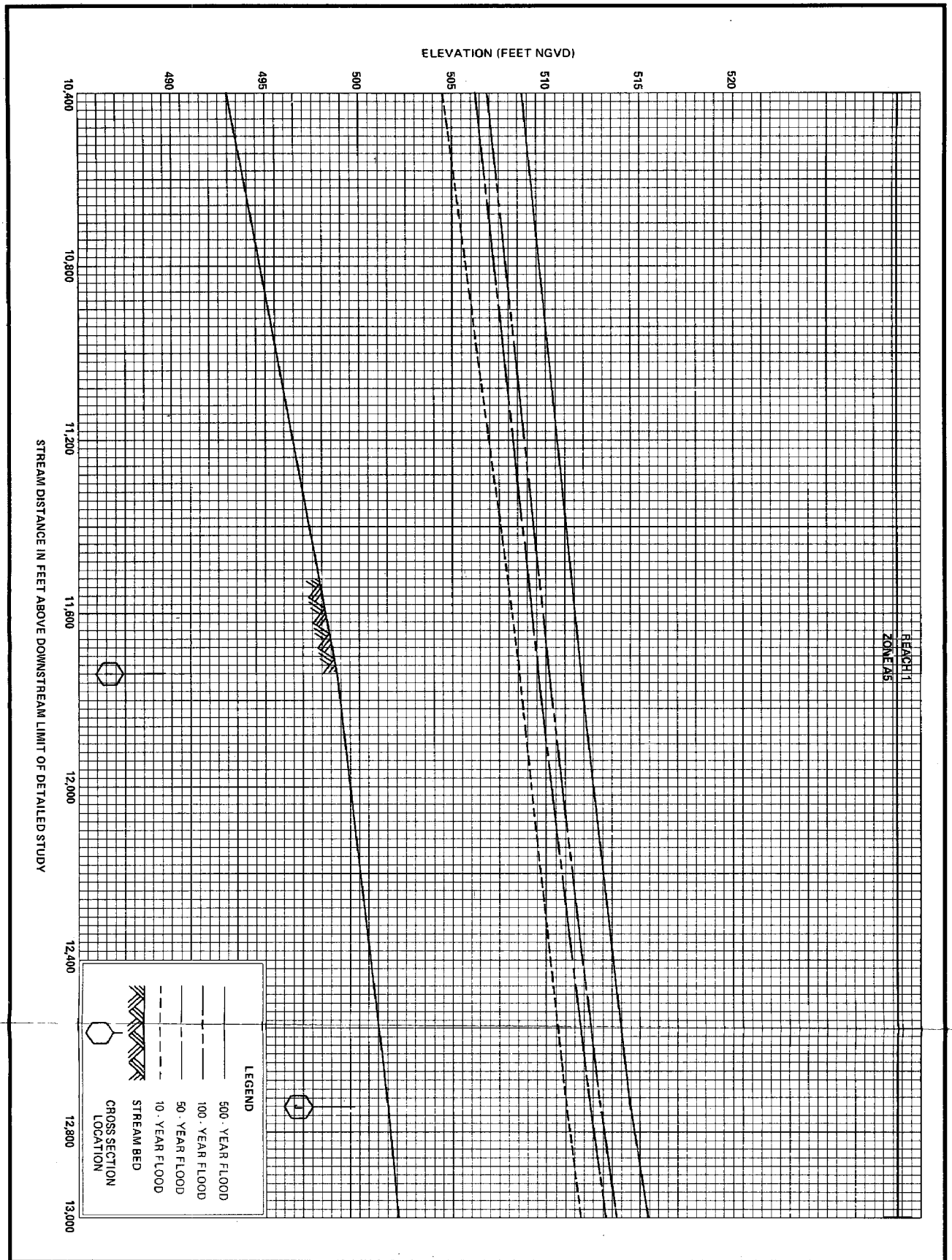
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

COW CREEK (NEAR MILLVILLE)



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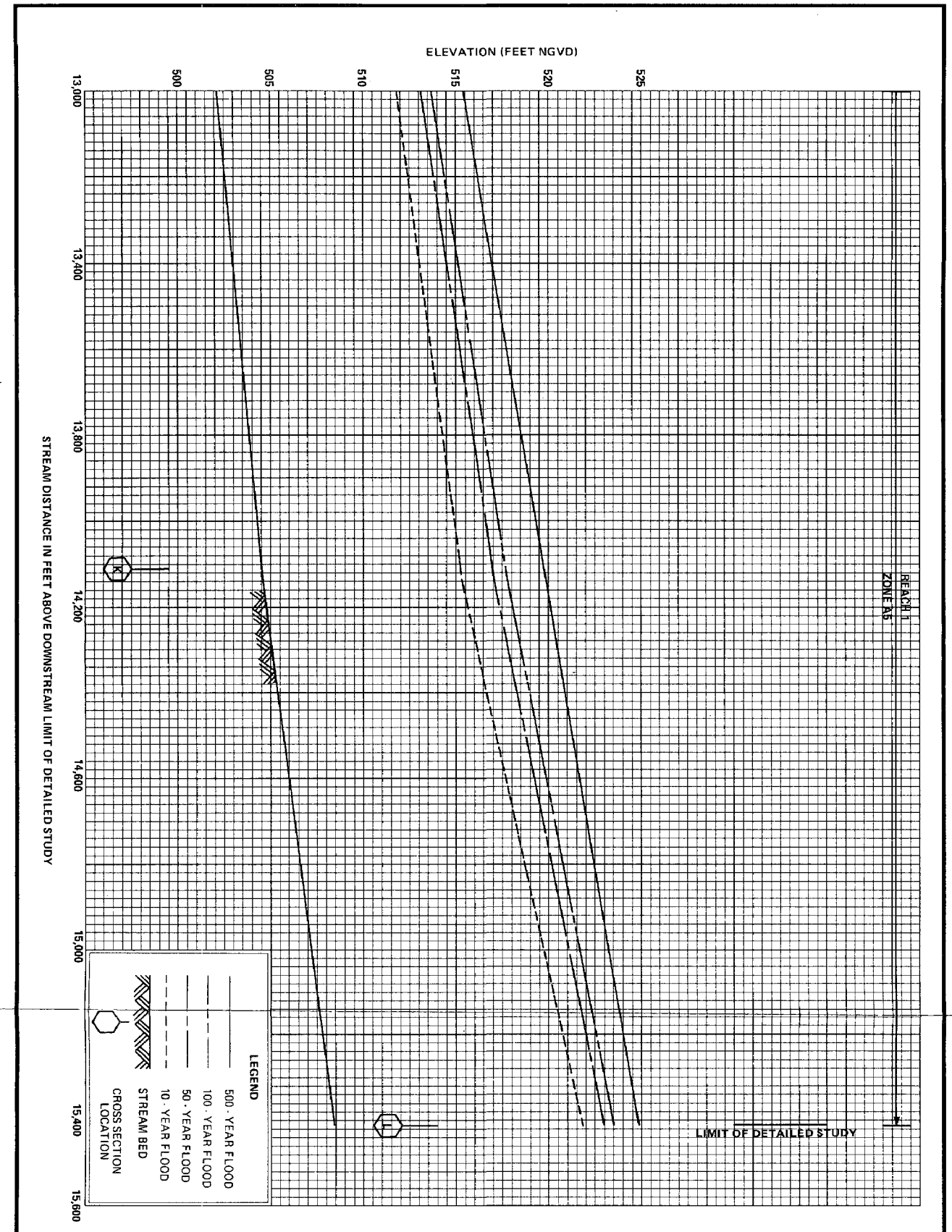
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

COW CREEK (NEAR MILLVILLE)

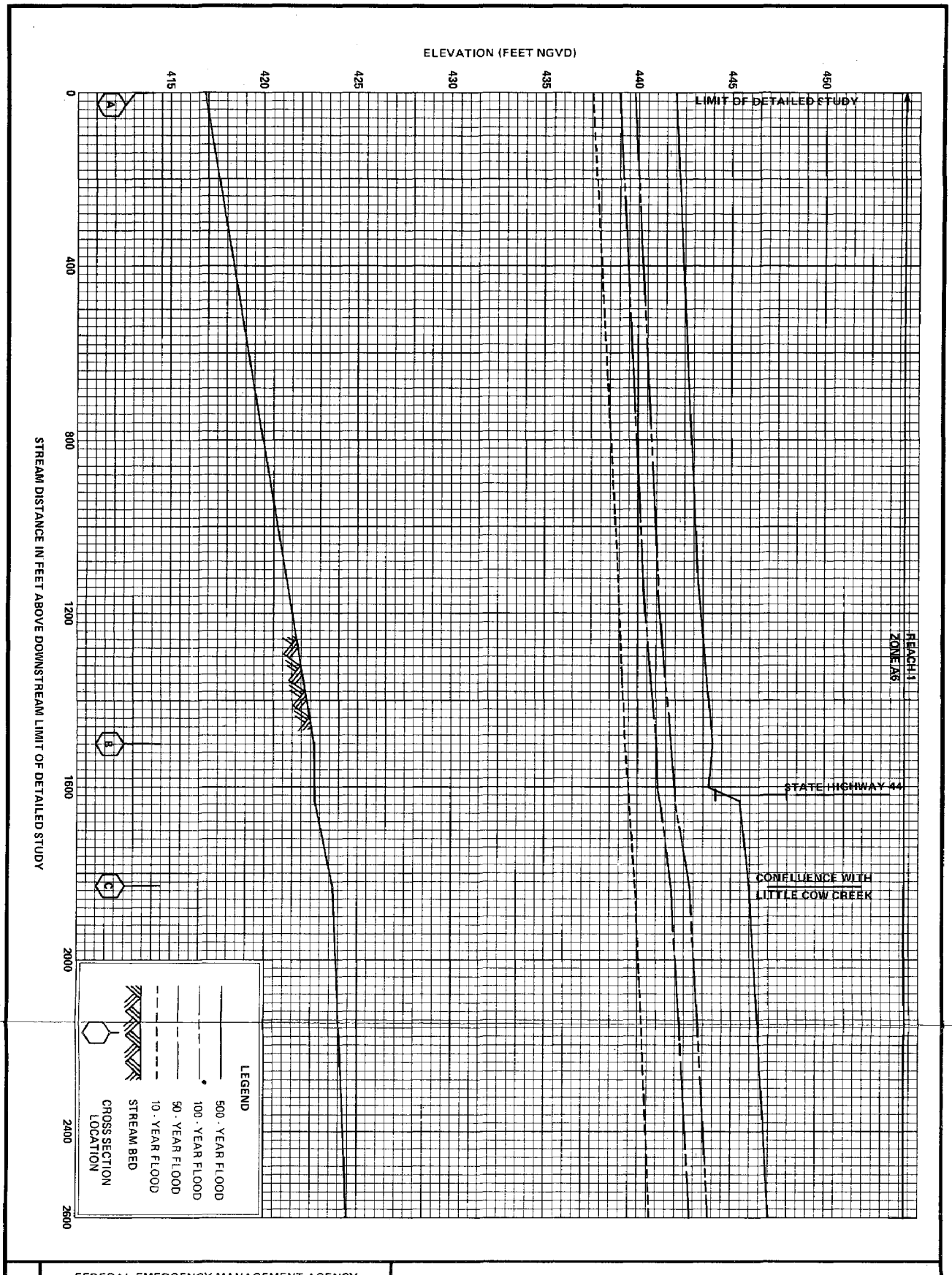


FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

COW CREEK (NEAR MILLVILLE)



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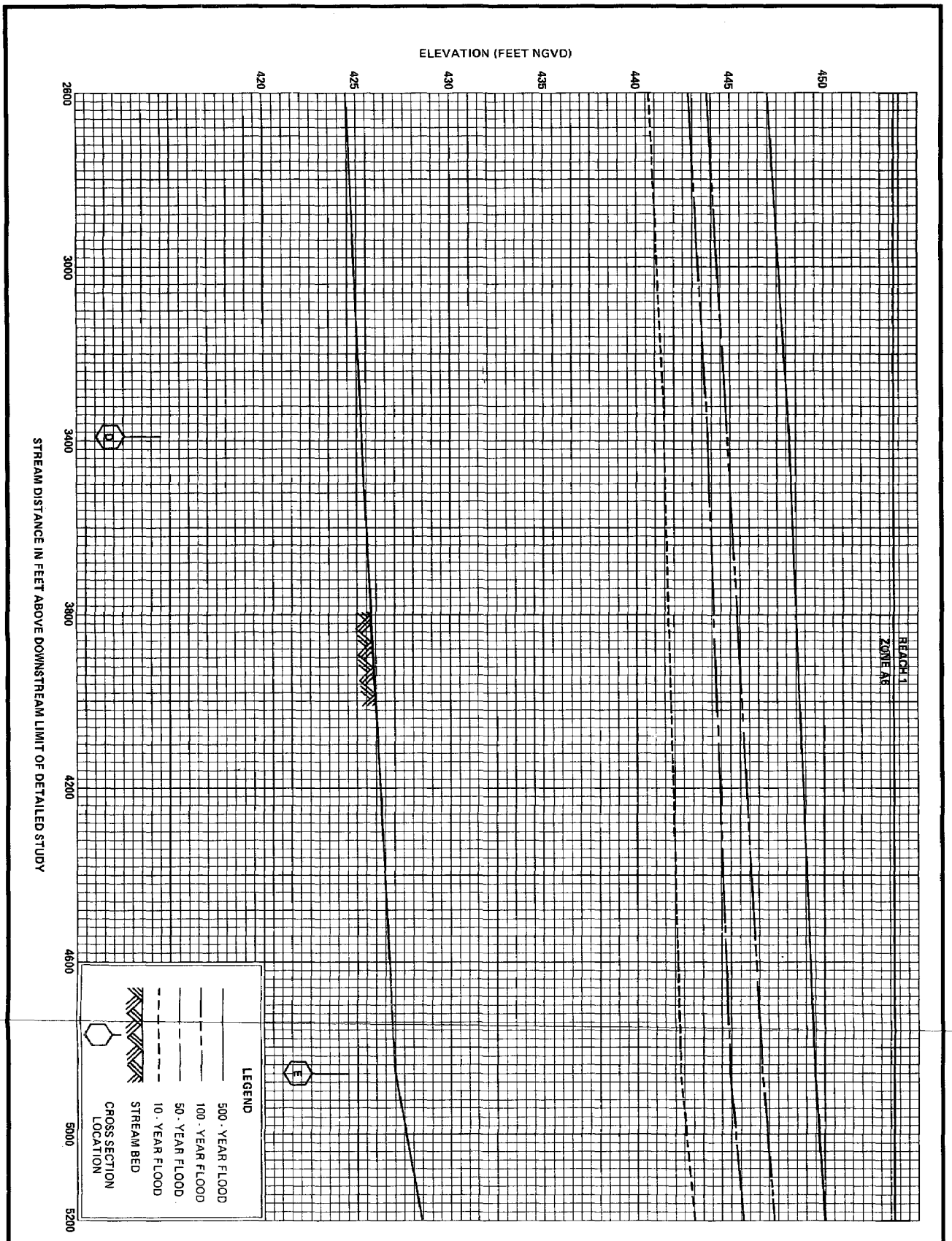
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

COW CREEK (NEAR PALO CEDRO)



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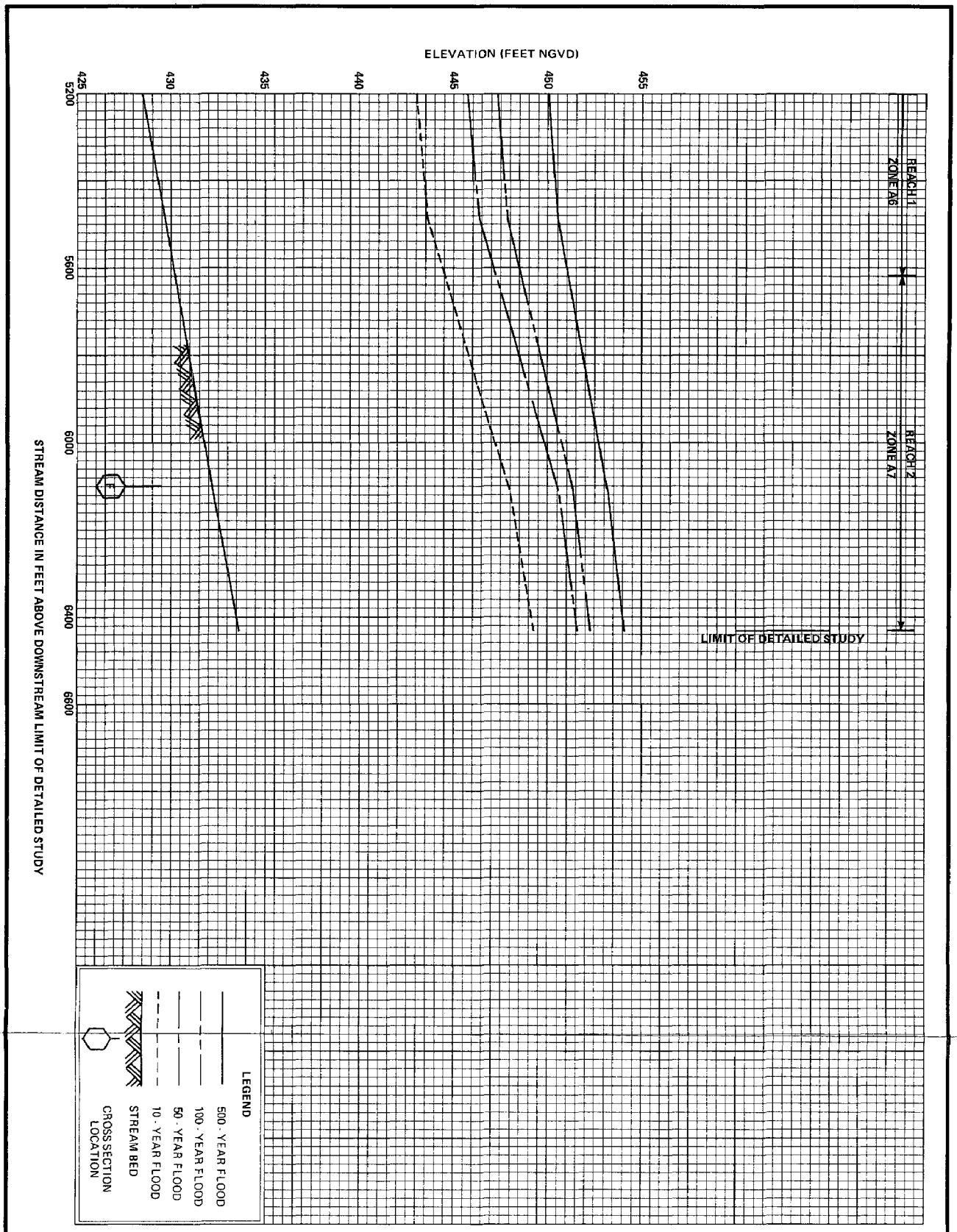
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

COW CREEK (NEAR PALO CEDRO)



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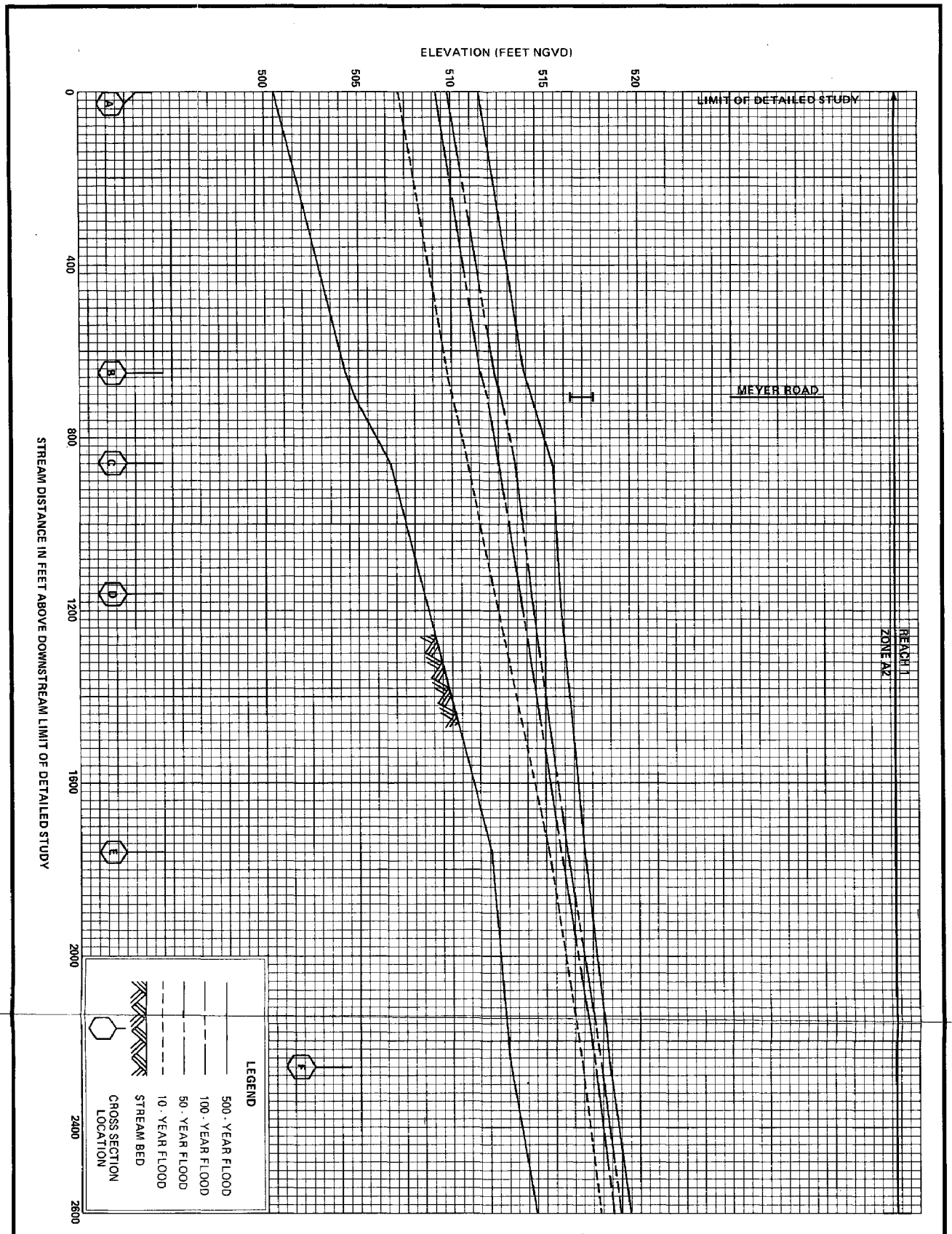
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

COW CREEK (NEAR PALO CEDRO)



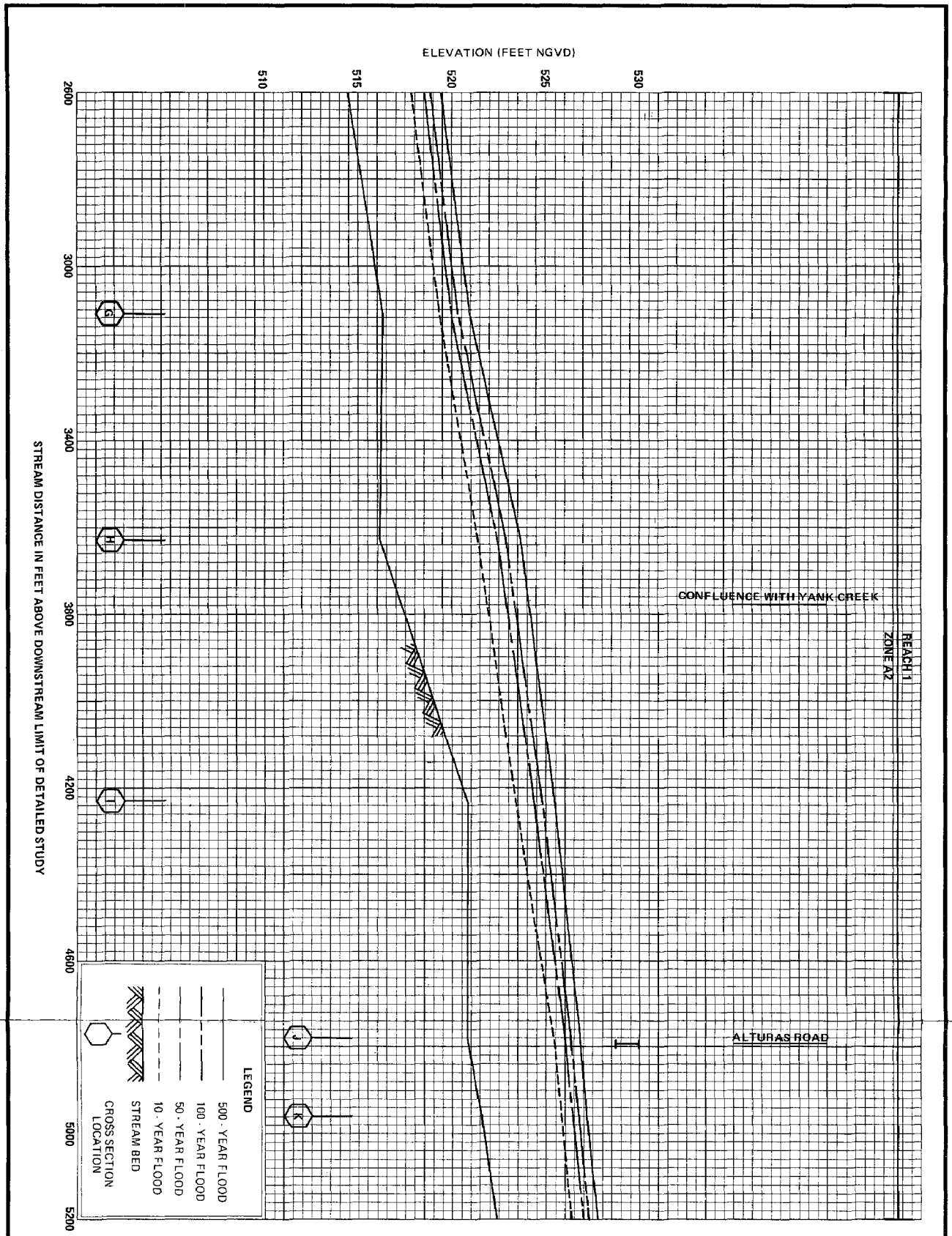
27P

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

DRY CREEK

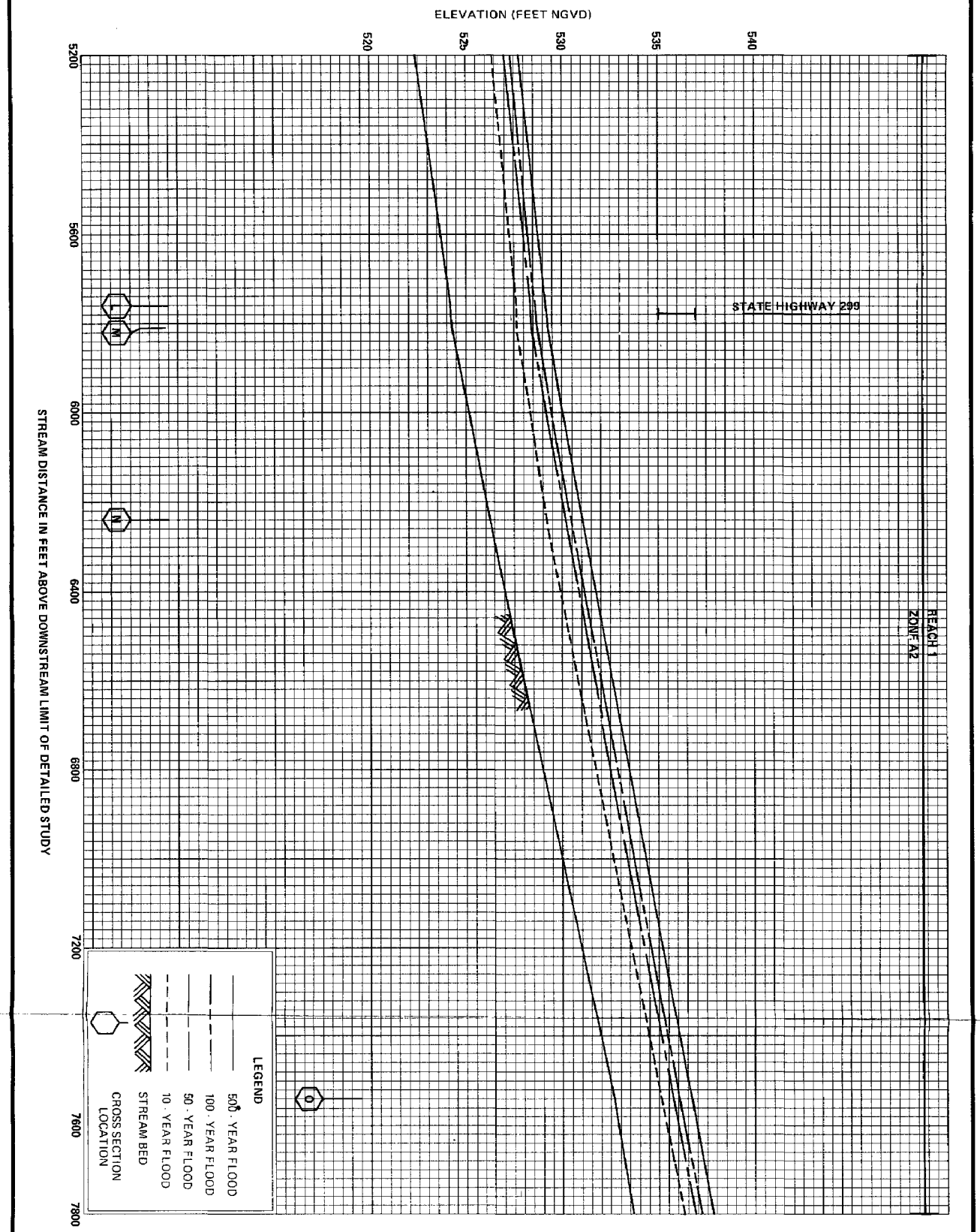


FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

DRY CREEK



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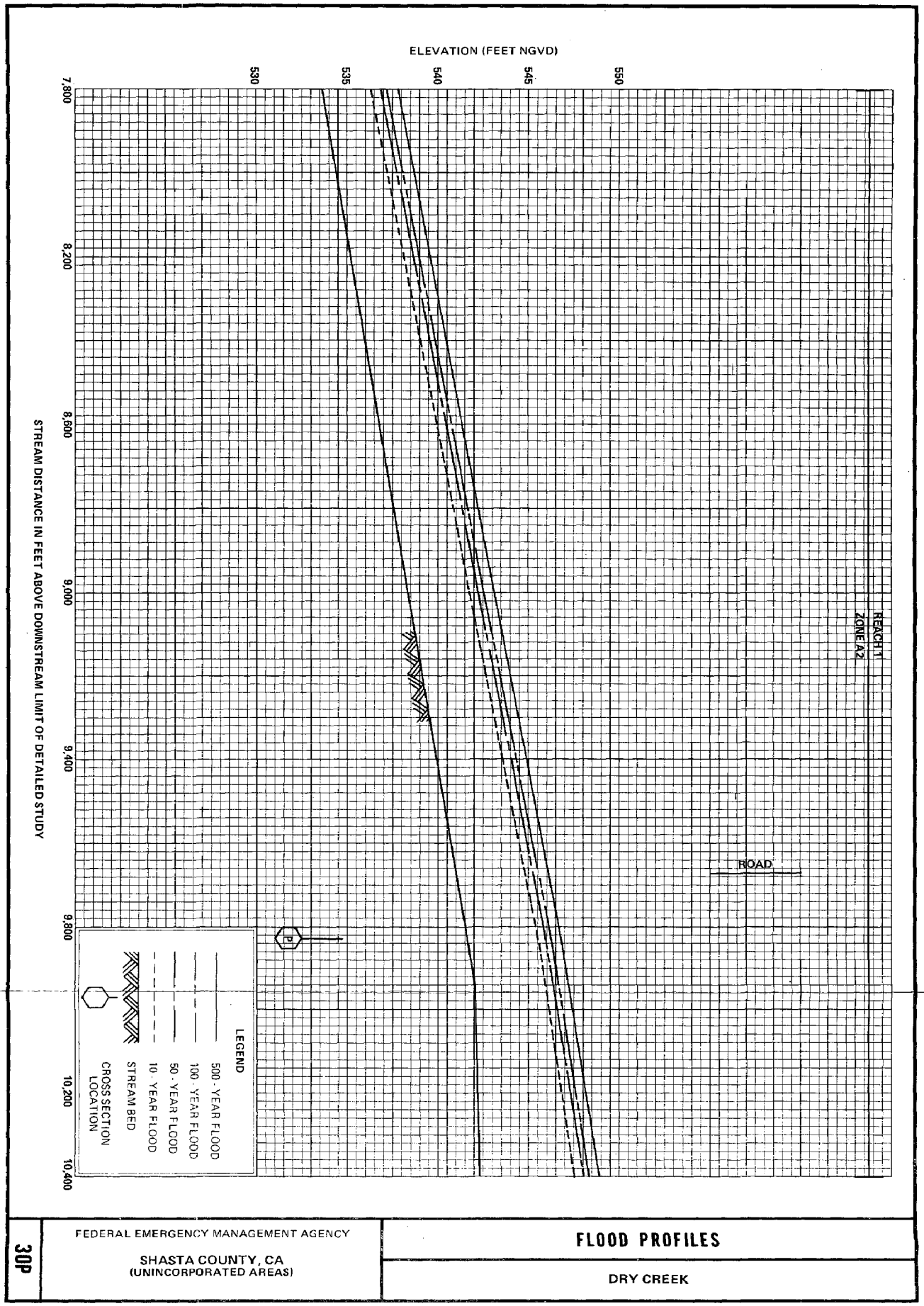
FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

DRY CREEK



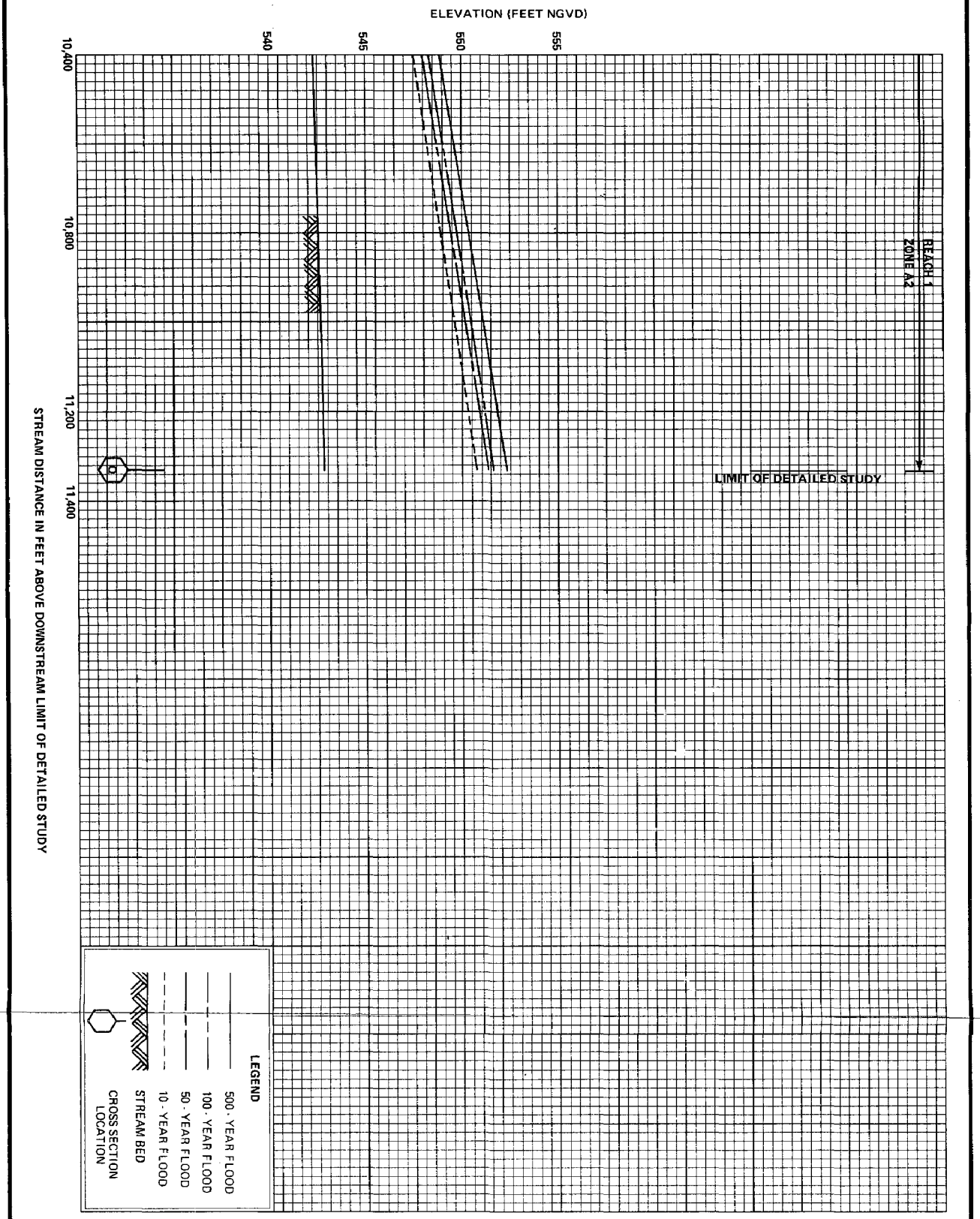
30P

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

DRY CREEK



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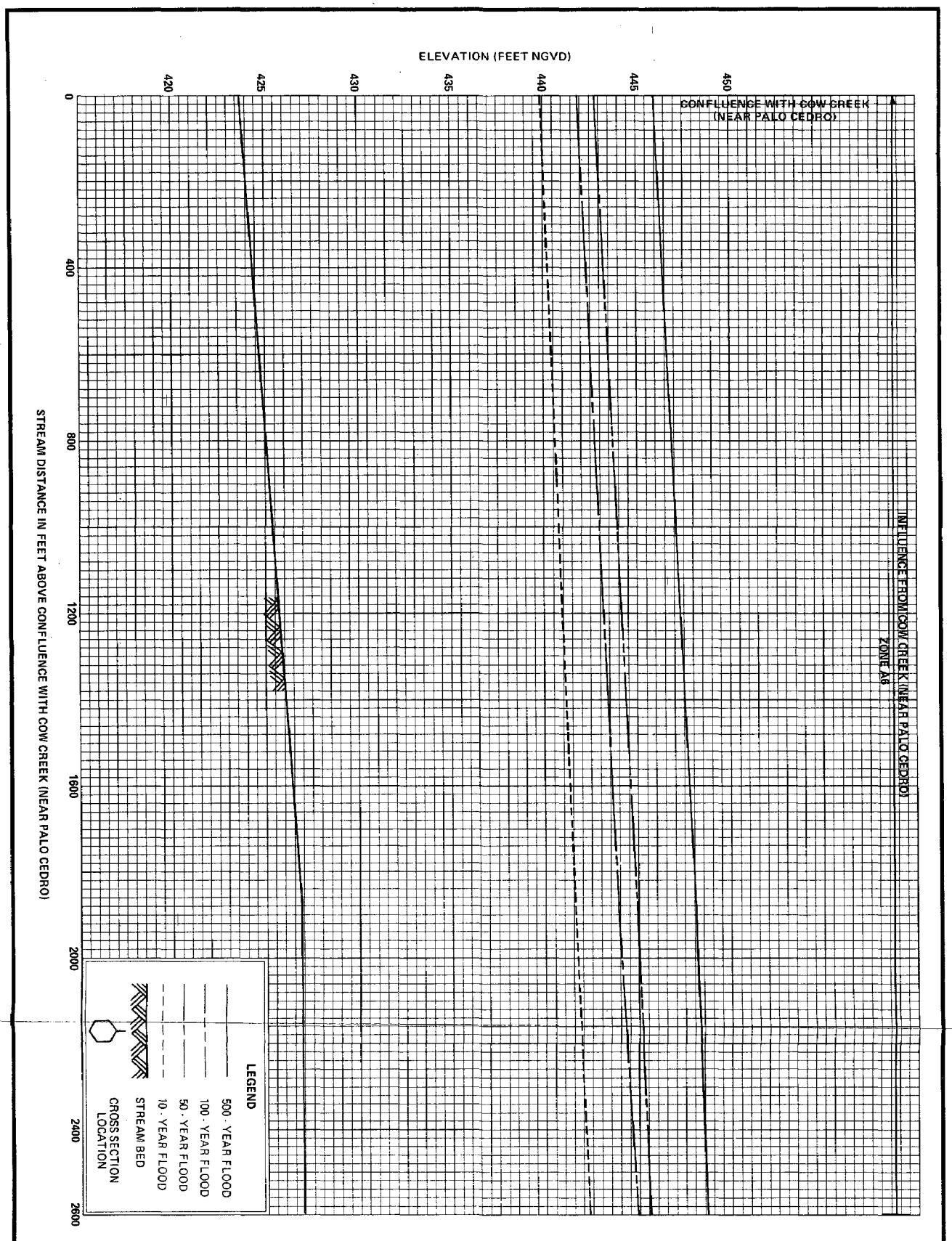


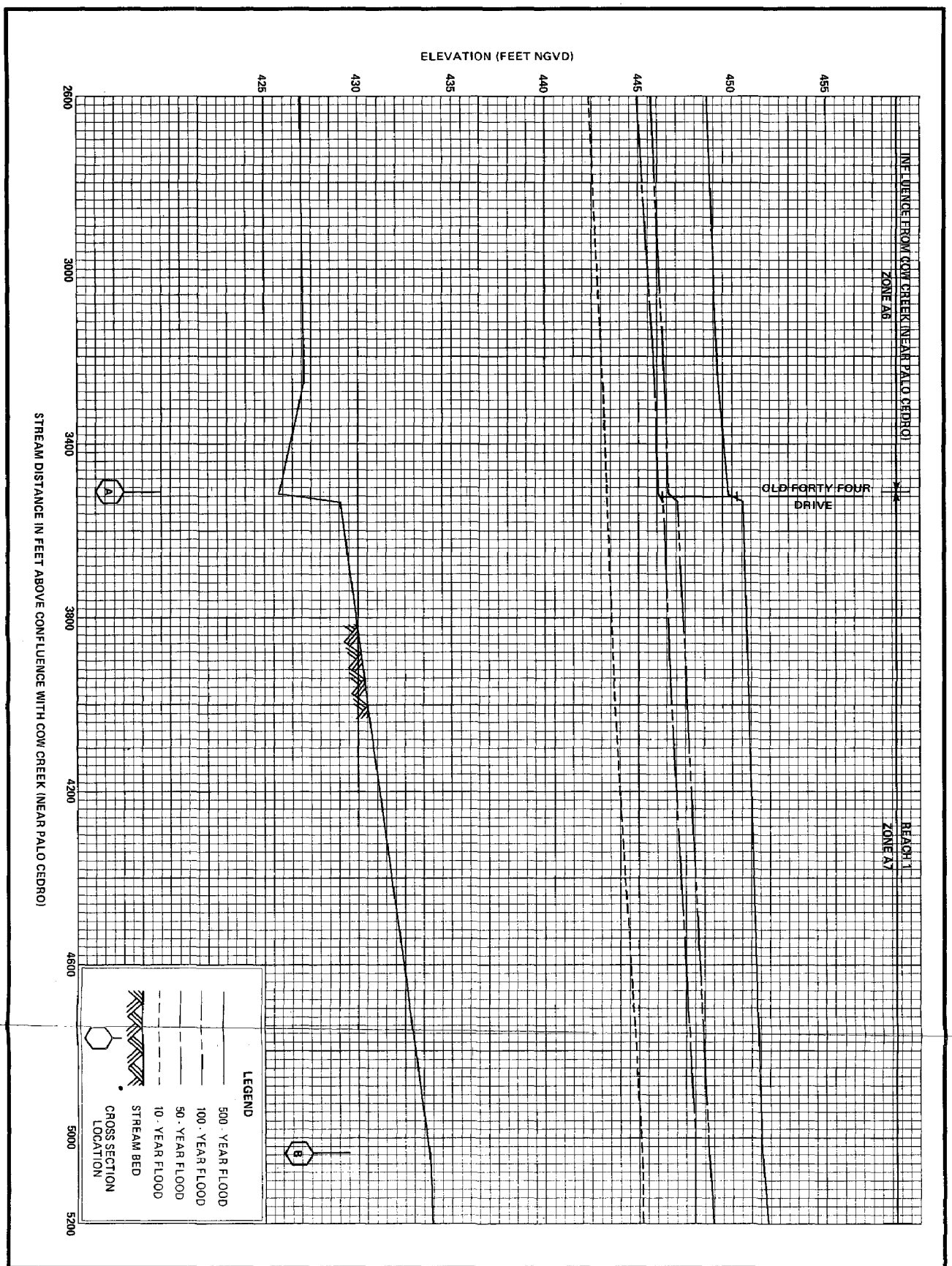
32P

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

LITTLE COW CREEK

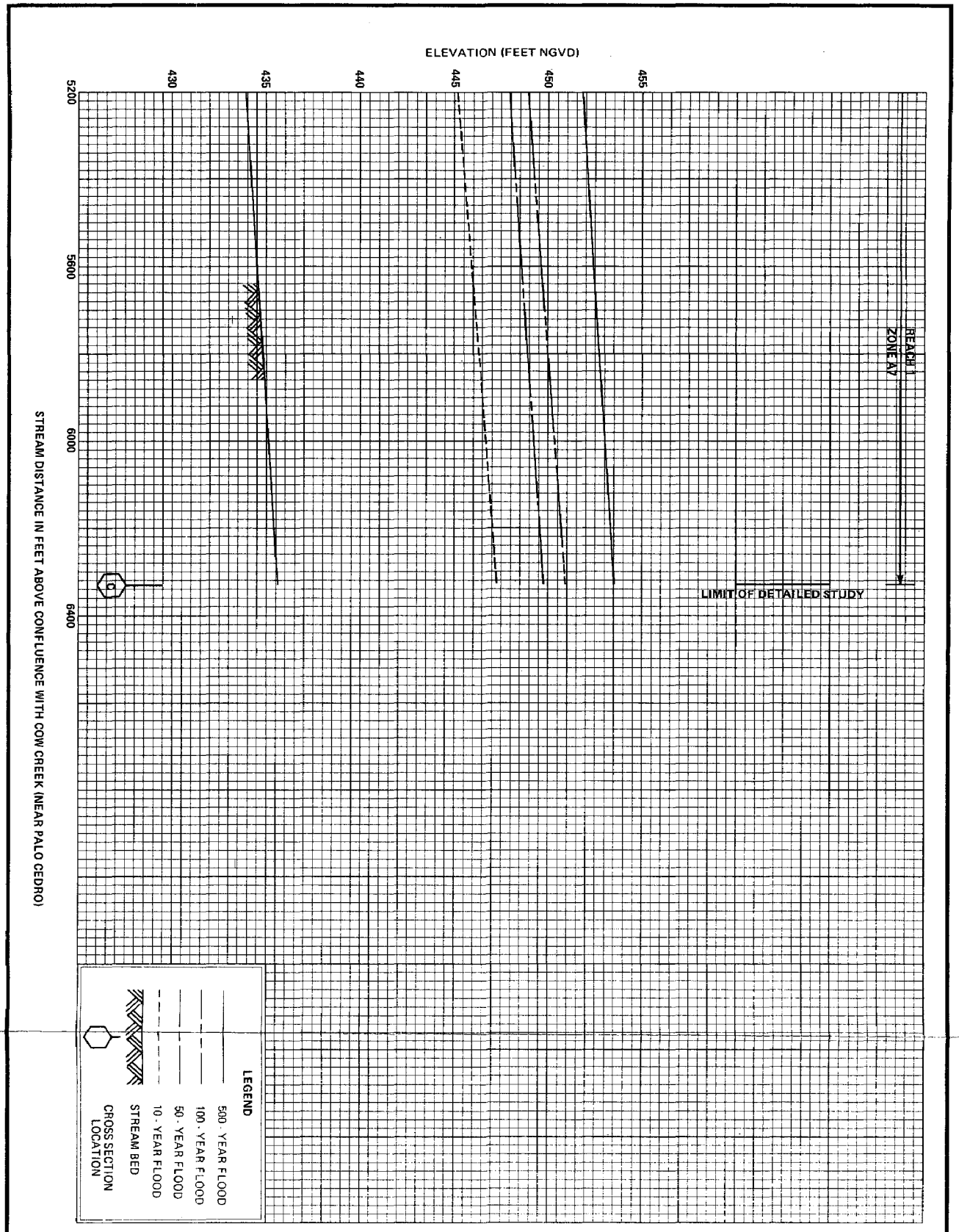


FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

LITTLE COW CREEK



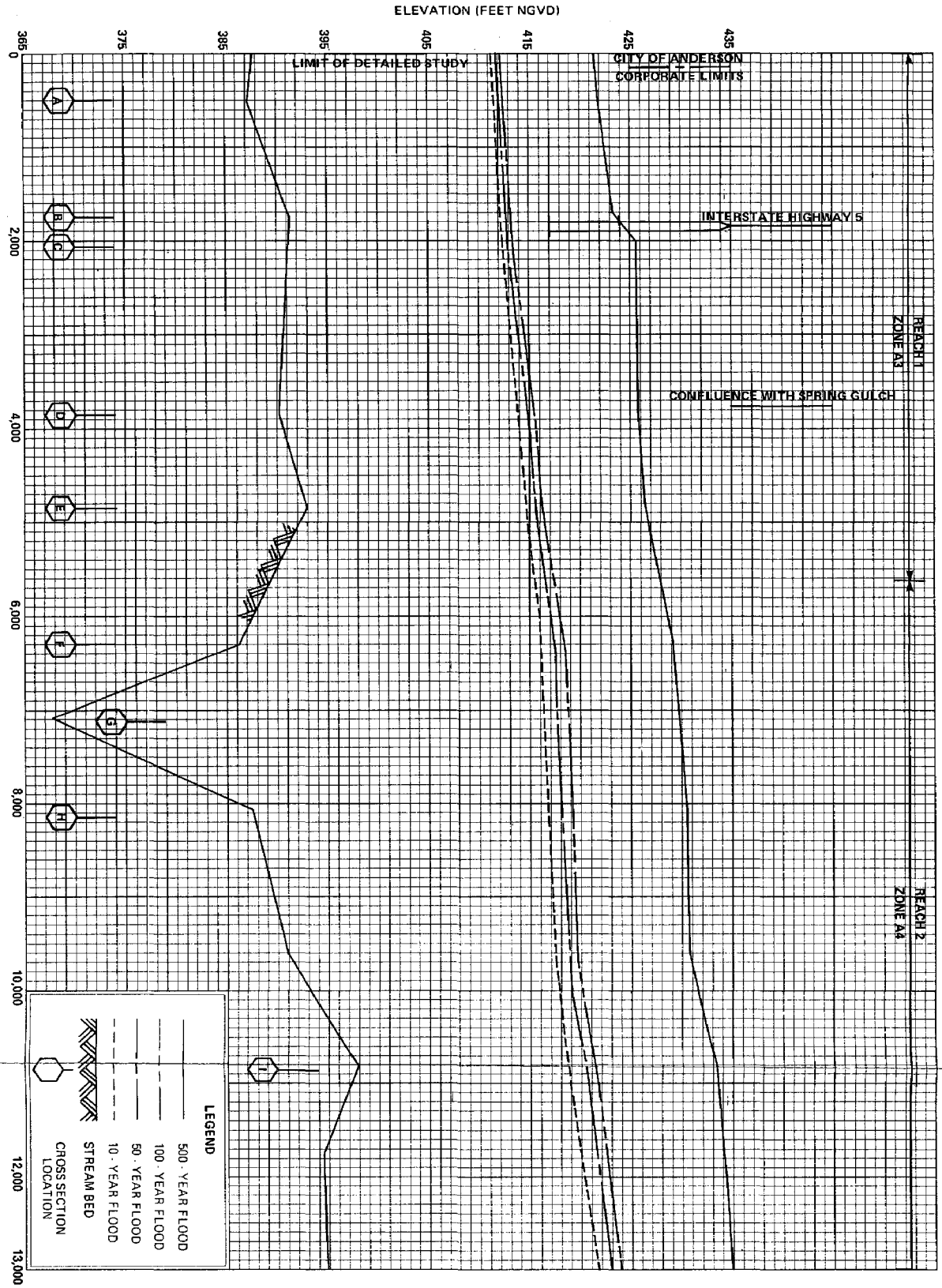
34P

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

LITTLE COW CREEK



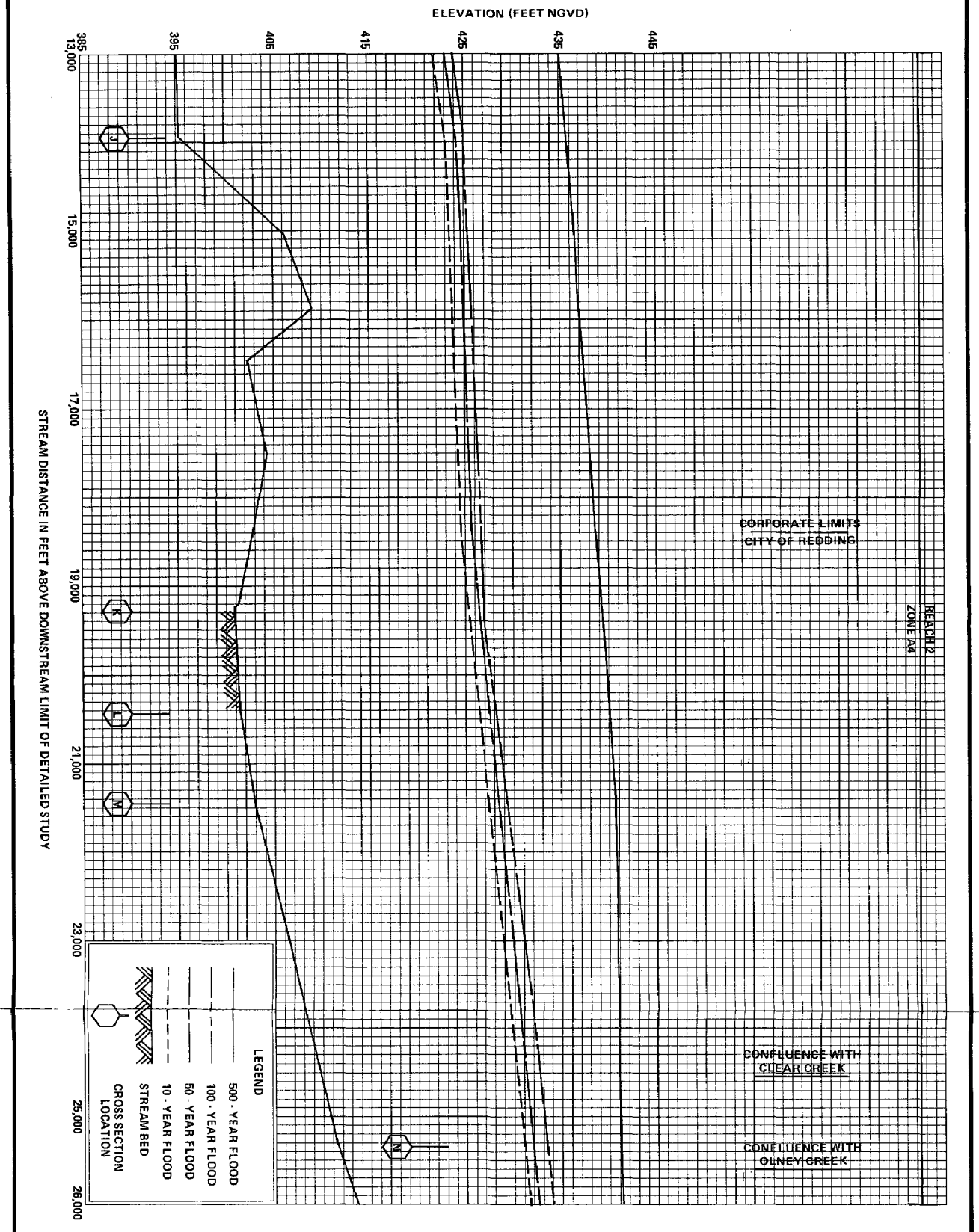
35P

FEDERAL EMERGENCY MANAGEMENT AGENCY

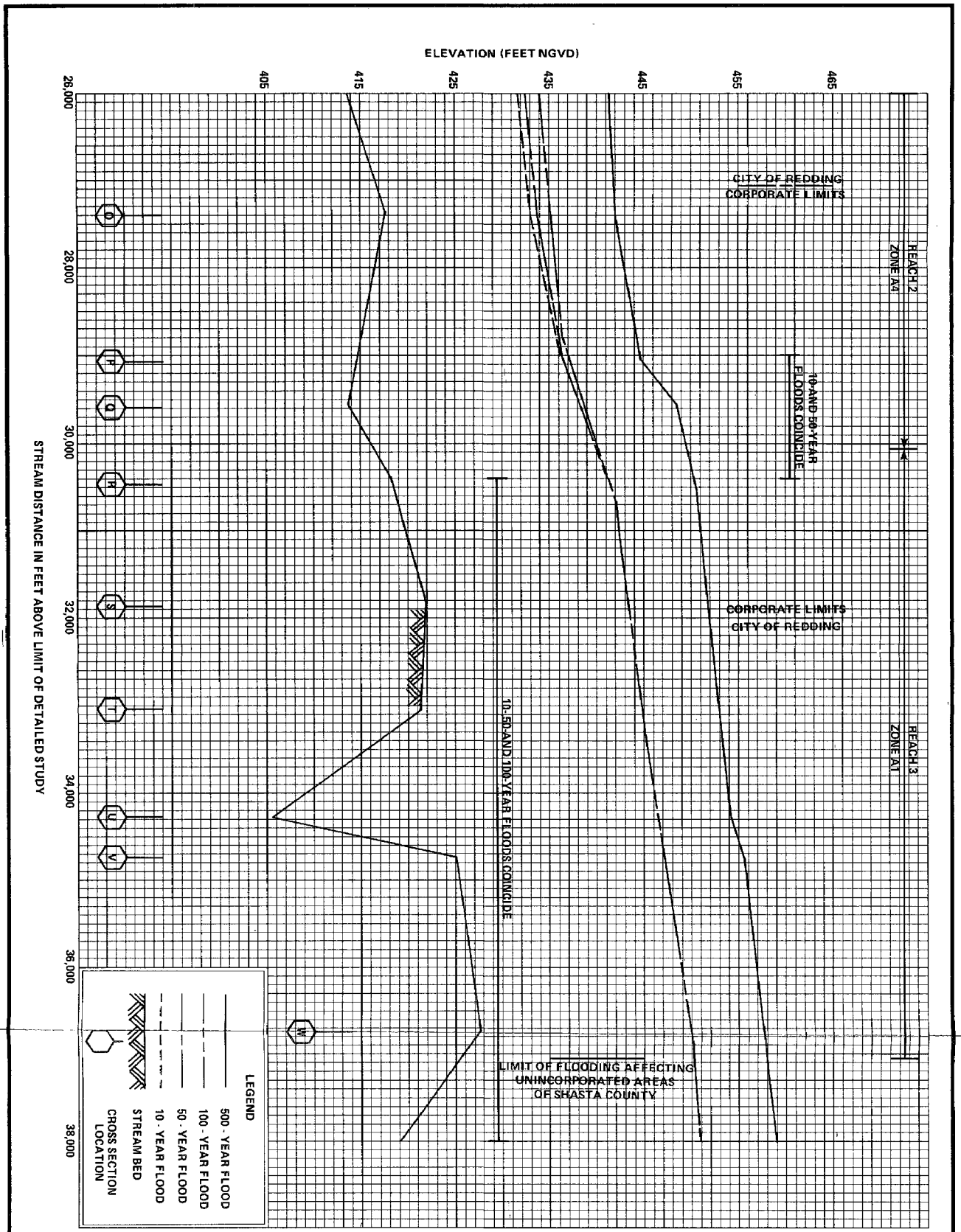
SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

SACRAMENTO RIVER



36P	FEDERAL EMERGENCY MANAGEMENT AGENCY SHASTA COUNTY, CA (UNINCORPORATED AREAS)	**FLOOD PROFILES** SACRAMENTO RIVER



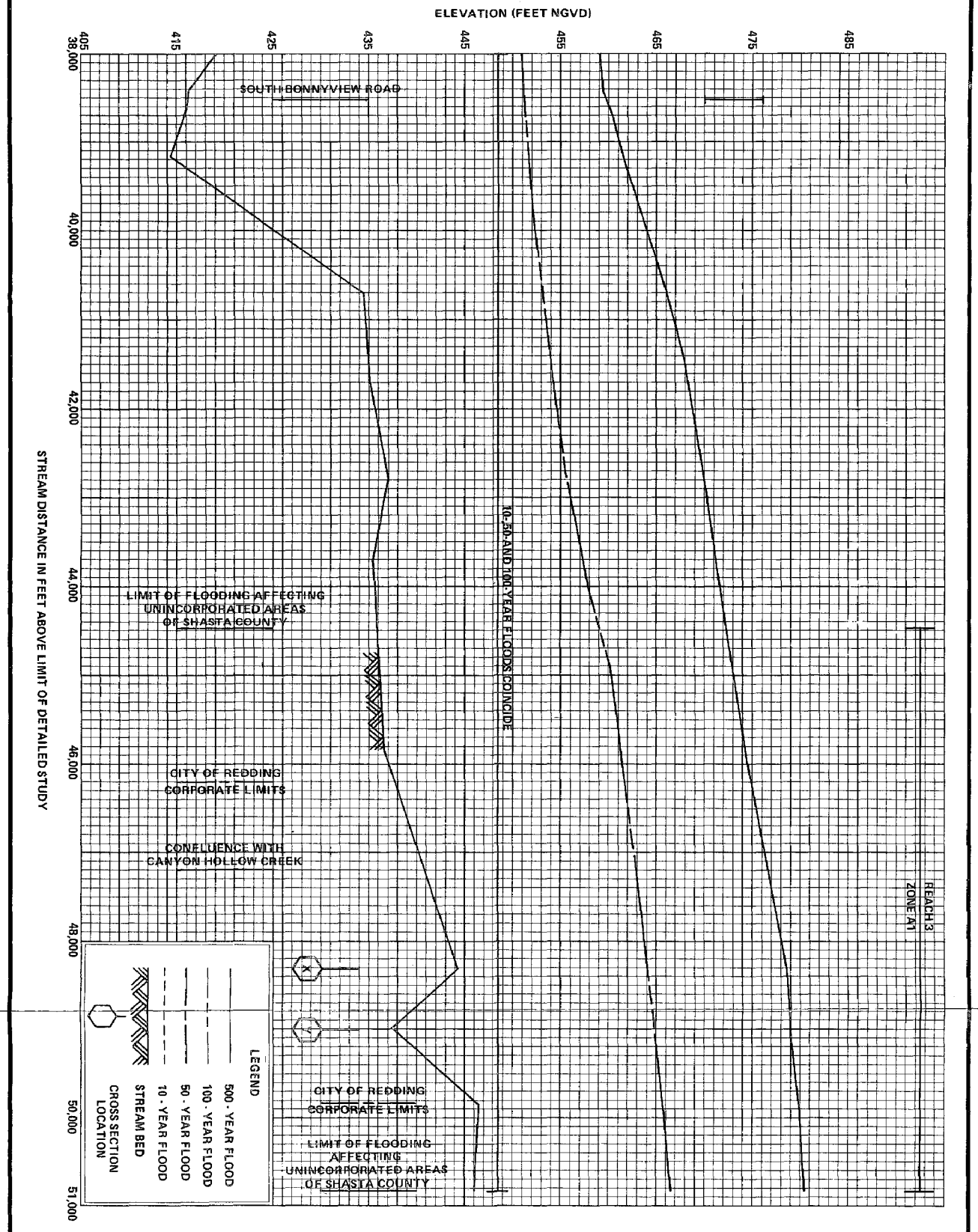
37P

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

SACRAMENTO RIVER



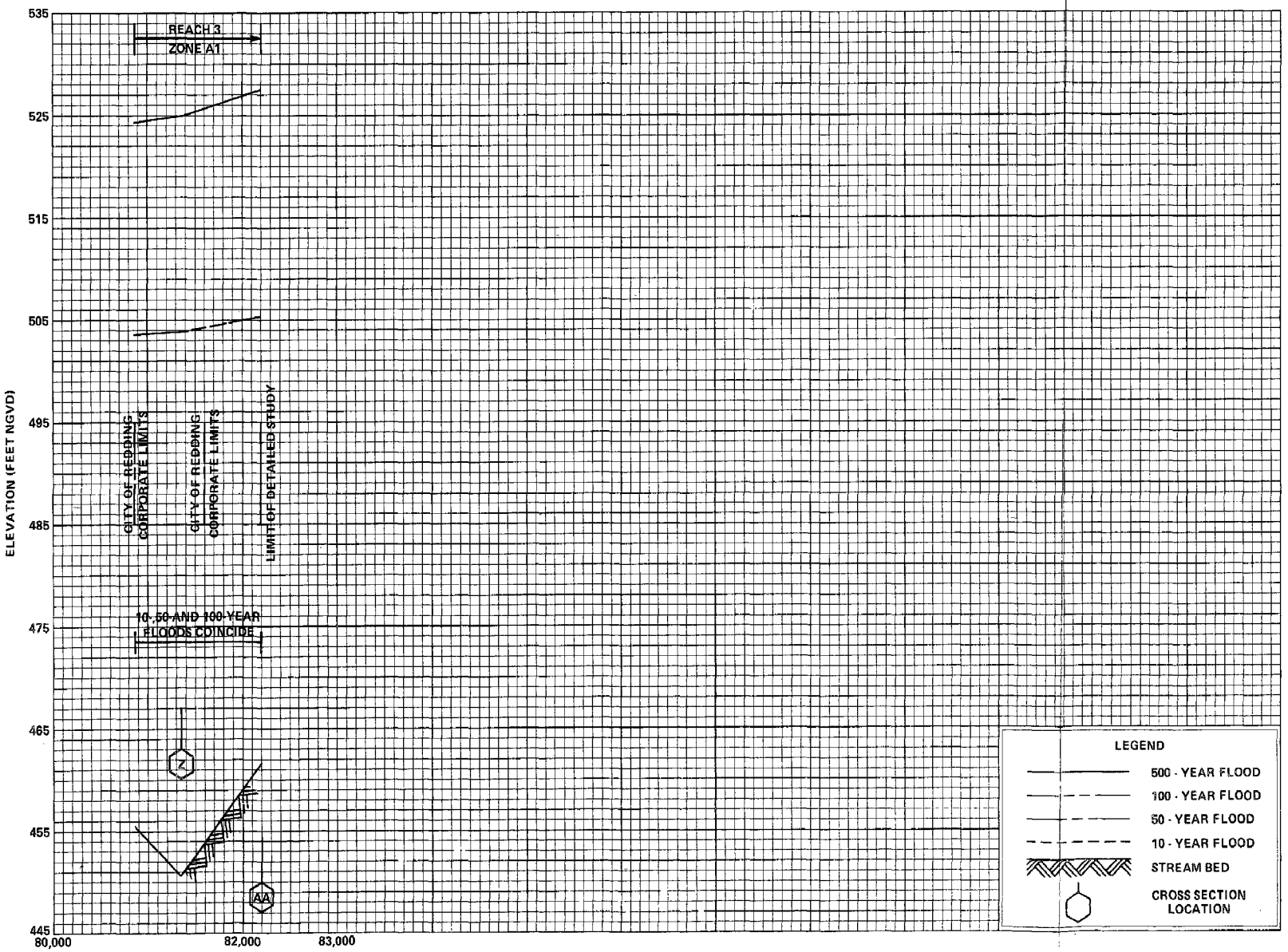
38P

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

SACRAMENTO RIVER

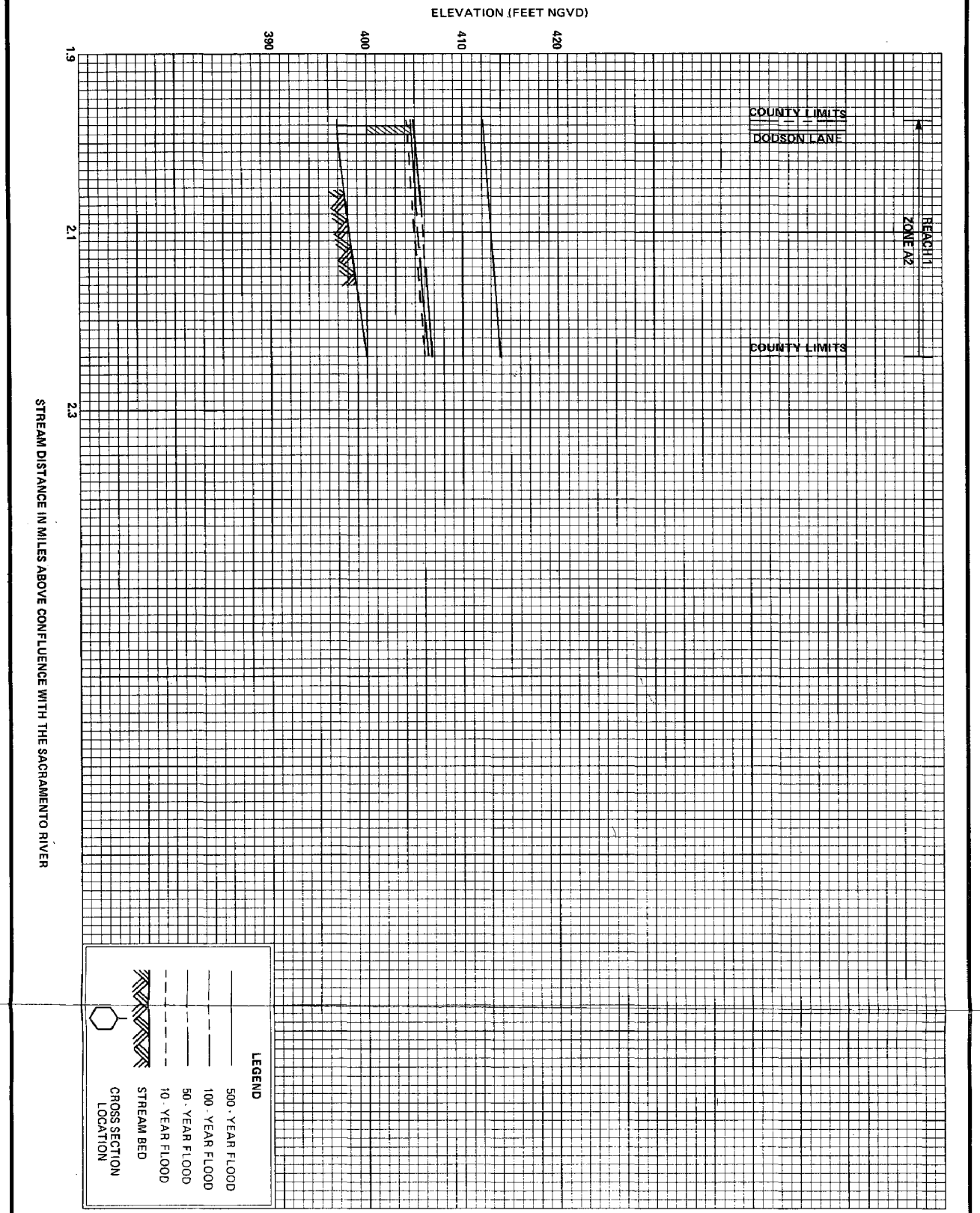


FLOOD PROFILES

SACRAMENTO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)



40P

FEDERAL EMERGENCY MANAGEMENT AGENCY

SHASTA COUNTY, CA
(UNINCORPORATED AREAS)

FLOOD PROFILES

TORMEY DRAIN